Household environmental factors towards Acute respiratory infection & Diarrhea of child under 5 in Bangladesh. A secondary analysis of Bangladesh Multiple Indicator Cluster Survey 2012-2013

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A Thesis Submitted in Partial Fulfillment of the Requirements
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ปัจจัยสิ่งแวดล้อมในบ้านที่มีความสัมพันธ์กับโรคติดเชื้อทางเดินหายใจเฉียบพลันและโรคท้องร่วง
ในกลุ่มเด็กอายุต่ำกว่า 5 ปี ประเทศบังกลาเทศ: ข้อมูลทุติยภูมิจากการสำรวจพหุดัชนีแบบจัด
กลุ่ม ปี 2012-2013 ประเทศบังกลาเทศ

นางสาวชากีนา ซัลทานา

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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ชากีนา ซัลทานา : ปัจจัยสิ่งแวดล้อมในบ้านที่มีความสัมพันธ์กับโรคติดเชื้อทางเดินหายใจเฉียบพลันและโรคท้องร่วงในกลุ่มเด็กอายุต่ำกว่า 5 ปี ประเทศบังกลาเทศ: ข้อมูลทุติยภูมิจากการสำรวจพหุดัชนีแบบจัดกลุ่ม ปี 2012-2013 ประเทศบังกลาเทศ (Household environmental factors towards Acute respiratory infection & Diarrhea of child under 5 in Bangladesh. A secondary analysis of Bangladesh Multiple Indicator Cluster Survey 2012-2013) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ปีเตอร์ ซีนอส, 96 หน้า.

หลักการและเหตุผล: ปัจจัยด้านสภาพแวดล้อมของที่อยู่อาศัยที่ไม่ยั่งยืนมีอิทธิพลต่อความเสี่ยงต่ออัตราการป่วยในเด็กที่มีอายุต่ำกว่า 5 ปี การขยายตัวของการติดเชื้อทางเดินหายใจเฉียบพลันในวัยเด็ก (ARI) และโรคอุจจาระร่วงในประเทศบังคลาเทศที่สูงมาก การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อเปรียบเทียบความสัมพันธ์ของปัจจัยแวดล้อมในครัวเรือนกับการติดเชื้อทางเดินหายใจเฉียบพลันในวัยเด็ก (ARI) และโรคอุจจาระร่วงในเด็กอายุ 5 ปี ในประเทศบังคลาเทศ

วิธีการวิจัย: การวิจัยนี้ได้ใช้ข้อมูลจากการสำรวจของ MICS ในระดับประเทศ เกี่ยวกับเด็กในเด็กอายุต่ำกว่า 5 ปี ในประเทศ บังคลาเทศ ซึ่งดำเนินการ โดยองค์การยูนิเซฟในช่วงปี พ.ศ. 2555-2556 โดยผู้หญิงที่มีอายุระหว่าง 15 ถึง 49 ปี ในครัวเรือน ที่เลือกไว้ได้ให้ข้อมูล 20903 เกี่ยวกับเด็กอายุต่ำกว่า 5 ปี และใช้เวลา 2 สัปดาห์ในการเก็บรวบรวมและบันทึก ข้อมูลของผลการตรวจวัดเบื้องต้นของอัตราการป่วยของเด็กที่ป่วยเป็นโรคอุจจาระร่วงและอาเจียน

ผลการวิจัย: ปัจจัยที่มีความสัมพันธ์กับ ARI ได้แก่ อายุเด็ก 6-11 เดือน มีอัตราส่วนออด (Odds Ratio) เท่ากับ 1.86 และมี ค่า p <0.001 ในเขตจิตตะกองและชุลนมี 2 ครัวเรือนที่ยากจน มีอัตราส่วนออด (Odds Ratio) เท่ากับ 1.5 และมีค่า p <0.001 กรณีที่มีอาการท้องร่วง คือเด็กอายุ 12-35 เดือน มีอัตราส่วนออด (Odds Ratio) เท่ากับ 5.2 และมีค่า P <0.001 แหล่งน้ำดื่ม มีอัตราส่วนออด (Odds Ratio) เท่ากับ 1.7 มีค่า P เท่ากับ 0.001 ที่ตั้งของแหล่งน้ำ มีอัตราส่วนออด (Odds Ratio) เท่ากับ 1.3 และมีค่า P เท่ากับ 0.015 ประเภทของห้องสุขา มีอัตราส่วนออด (Odds Ratio) เท่ากับ1.3 และมีค่า P เท่ากับ 0.001 สุขาภิบาลที่ใช้ร่วมกัน มีอัตราส่วนออด (Odds Ratio) เท่ากับ1.2 และมีค่า P เท่ากับ 0.02

ผลสรุป: ผลจากการวิจัยครั้งนี้แสดงให้เห็นถึงความสำคัญของการพัฒนาและดำเนินการตามแผนยุทธศาสตร์เพื่อลดระดับ ความยากจนและปรับปรุงสภาพแวดล้อมของครอบครัวในประเทศบังคลาเทศ การวัดเชิงป้องกันควรมีมากขึ้นเพื่อลดความ เสี่ยงทั้ง ARI และโรคอุจจาระร่วงในเด็กวัยแรกเกิดที่อายุน้อยมาก การส่งเสริมสุขอนามัยด้านน้ำและสุขาภิบาลสามารถช่วย ลดความแพร่หลายของโรคอุจจาระร่วงในวัยเด็กได้ อย่างไรก็ตาม กลยุทธ์เหล่านี้จำเป็นต้องรวมเข้ากับการศึกษาด้านสุขภาพในระดับ ปฐมภูมิ เพื่อที่จะทำให้โอกาสที่ความเสี่ยงของการติดเชื้อทางเดินหายใจเฉียบพลันลดลง

คำสำคัญ: สภาพแวดล้อมในครัวเรือน การติดเชื้อเฉียบพลันระบบทางเดินหายใจ โรคอุจจาระร่วง MICS

สาขาวิชา สาธารณสุขศาสตร์	ลายมือชื่อนิสิต ....
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Unsustainable household environmental factors influences the risk of children under 5 morbidities. The prevalence of childhood Acute respiratory infection(ARI) and diarrhea considerably high in Bangladesh. The objective of this study to compare the associations of household environmental factors and ARI and diarrhea among child 5 years in Bangladesh The data were obtained from a MICS survey at national level about child among child under 5 years in Bangladesh conducted by the UNICEF in 2012-2013. Women aged between 15 and 49 years living in selected households provided information on 20903 of their children under the age of 5 years. Primary outcome measure the morbidity status of the children was recorded with respect to episodes of diarrhea and ARI in the 2 weeks preceding data collection The factors associated with ARI were: child age 6-11months OR: 1.86; p :<0.001, Chittagong and Khulna divisions :2 poor household OR :1.5; p:<0.001, In case of diarrhea were: child age 12-35months OR: 5.2; p:<0.001; source of drinking water OR :1.7; p:0.001; location of water source OR :1.3; P: 0.015; types of toilet facility OR: 1.3; p:0.001; shared sanitation OR: 1.2; p:0.02. Results from this research underline the importance of developing and implementing strategic plans to reduce poverty level and improve household environment in Bangladesh. Preventive measurements acquire more to lower the risk of both ARI and diarrhea in very early age group of children. Promoting hygienic water and sanitation facilities can help reduce the prevalence of childhood diarrhea. However, these strategies need to be integrated with health education in primary level raise the likelihood that reduced risks are acute respiratory infections.

Field of Study: Public Health	Student's Signature ....
Academic Year: 2016	Advisor's Signature ....

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✓ ARI	Acute Respiratory Infections
✓ CI	Confidence interval
✓ DALY	Disability Adjusted Life Year
✓ DHS	Demographic and Health Survey
✓ LPG	Liquefied Petroleum Gas
✓ MGD	Millennium Development Goals
✓ MICS	Multiple Indicator Cluster Survey
✓ OR	Odds Ratio
✓ UNICEF	United Nations Children’s Fund
✓ WHO	World Health Organization

CHAPTER I

INTRODUCTION

1.1Background:

Worldwide, acute diarrhea and acute respiratory tract infections (ARTI) are responsible for almost 30 % of deaths among children under 5 years of age(Liu et al., 2012) In low-income countries, the annual incidence remains high with an estimated 2.5 billion cases of diarrhea and 151 million episodes of ARTIs, making them the first and second causes of disability-adjusted life-years (DALYs) in children. These diseases are mainly concentrated in 15 countries, including Bangladesh , that account for more than 80 % of worldwide diarrhea and pneumonia deaths(Agustina, Shankar, Ayuningtyas, Achadi, & Shankar, 2015).

WHO Global Health Observatory (GHO) data estimated in 2015, about half of 5.9 million deaths U5M were occurred due to infectious diseases and conditions, including pneumonia (16%), diarrhea (9 %), and malaria (5%). Environmental conditions are affiliate to these 60% of acute respiratory infections and 80 to 90 % of diarrheal cases (Organization, 2015)

Acute respiratory infections (ARI) are classified into two groups based on the site of infection; acute lower respiratory infections (ALRI) and acute upper respiratory infections (AURI). Acute lower respiratory infections in children include pneumonia, bronchiolitis, bronchitis, laryngitis, epiglottitis and pharyngotonsilitis (WHO, 2008). Childhood pneumonia is the leading cause of under 5 deaths in the world. In the household air pollution exposure, the risk becomes twice. In under 5 deaths, over 50% from acute lower respiratory infections (ALRI) are related to particulate matter inhaled from indoor air pollution from household solid fuels (WHO, 2014). Household air pollution is the single most important environmental health risk worldwide, and women and children are in higher risk from the exposure. Around 3 billion people are using solid fuels (i.e. wood, crop wastes, charcoal, coal and dung) in open fires and leaky stoves for cooking and heating their homes. Over the past decades this number almost remain same where prevalence is higher in South Asia and sub-Saharan Africa. (Jary et al., 2016) (WHO,2016).

ARI are described as ‘presumed pneumonia’ to better reflect probable cause and the recommended interventions. The definition of ARI used in the Multiple Indicator Cluster Surveys (MICS) is based on mothers’ perceptions of a child who has a cough, is breathing faster than usual with short, quick breaths or is having difficulty breathing, excluding children that has only a blocked nose (UNICEF, 2006; WHO, 2008).

Diarrhea is the second leading cause of death among children less than 5 years of age in lower income countries, resulting in ~1.3 million deaths globally each year, mostly in Africa and South Asia.(Wilson et al., 2012) In the past three decades, the world has made significant improvements in child survival, despite significant investments in the prevention of diarrheal-related morbidity and mortality, diarrhea remains one of the leading sources of under-5 mortality (U5M) worldwide, leading to more than 2,100 under-5 deaths daily (Ogbo et al., 2017).

As a second leading cause of death in children under 5, Diarrheal disease alone responsible on estimated 3.6 % of the total DALY global burden of disease. In addition ,58% of that burden, is attributable to unsafe water supply, sanitation and hygiene that leads to 361 000 deaths in under 5 children, mostly in low-income countries. Repeated diarrheal also the leading determinate of under 5 malnutrition, which becomes more worsen in each diarrheal episode. (WHO 2014).

. WHO defines diarrhea is the passage of 3 or more loose or liquid stools per day, or more frequently than is normal for the individual. It is usually a symptom of gastrointestinal infection, which can be caused by a variety of bacterial, viral and parasitic organisms. Infection is spread through contaminated food or drinking-water, or from person to person as a result of poor hygiene. (Kosek, Bern, & Guerrant, 2003). In 2006s world health report mentioned "no matter how motivated and skilled health workers are, they cannot do their jobs properly in facilities that lack clean water"

Globally 663million people don't have improved drinking water sources, one fifth of them live in Southern Asia. In addition, 2.4 billion people still use unimproved sanitation facilities. Children living in such environments are more likely to experience higher risk of morbidity and mortality (Dos Santos et al., 2015). At the MDG period, top priority for improving health and nutrition is to complete elimination of open defecation of low and lower middle income country populations. Nearly two third open defectors are from South Asia that is 3 times higher than in sub-Saharan Africa. (WHO/UNICEF ,2015).

Breast milk is an 'individualized medicine' for the infant include stimulation of the infant immune system, maintenance of the microbial changes in the infant's gastrointestinal system, and stimulation of the epigenetic programming of the infant .the World Health Organization and United Nations Children's Fund (WHO/UNICEF) recommend the initiation of breastfeeding within the first hour of birth and exclusive breastfeeding and introduction of safe and nutritionally adequate complementary foods around the age of six months with continued breastfeeding until 2 years and beyond .this study found that diarrhea prevalence was lower among children whose mothers practiced early initiation of breastfeeding, exclusive and predominant breastfeeding. Infants who were introduced to solid, semi-solid and soft foods and those who continued breastfeeding at one year had a higher prevalence of diarrhea compared to their counterparts.(Ogbo et al., 2017) s a protector against infection, various studies have been reported breastfeeding for reducing risk of respiratory illness among infants(Naz, Page, & Agho, 2016)

Undernutrition puts children at greater risk of dying from common infections, increases the frequency and severity of such infections, and contributes to delayed recovery.(Hoque, Sayeed, Ahsan, Al Mamun, & Salim, 2016) In 2015, under one in four children under age 5 worldwide had stunted growth. Among them two out of every four stunted children lived in South Asia .in children under 5years ,42 million were overweight and 50 million were wasted and 17 million were severely wasted& half of all wasted children lived in South Asia(UNICEF) In a well-nourished population, there is a reference distribution of height and weight for children under age five. Under-nourishment in a population can be gauged by comparing children to a reference population. The reference population used in this MICS is based on the WHO growth standards. Each of the three nutritional status indicators – weight-for-age, height-for-age, and weight-for-height - can be expressed in standard deviation units (z-scores) from the median of the reference population. Weight-for-age is a measure of both acute and chronic malnutrition. Height-for-age is a measure of linear growth. Weight-for-height can be used to assess wasting and overweight status(Glover-Amengor et al., 2016)

A WHO reported that achieving MDG 4will depend on renewed efforts to prevent and control pneumonia, diarrhea, and under nutrition in all its regions (Bryce et al., 2005). This study will explore the relationship between house hold environment and maternal socio- demographic factors, child’s demographic factors, as independent variables and Diarrhea and ARI morbidity as dependent variable in children aged less than five years. The study will use data from the Bangladesh MICS conducted by the Bangladesh Bureau of Statistics (BBS) supported by UNICEF Bangladesh, December 2012-April 2013. The survey was based on the need to monitor progress towards the goals and targets that emanated from two international agreements; the millennium declaration, and the Plan of Action of "A World Fit for Children". Bangladesh has signed both of the agreement to improve conditions for all children ever born and monitor progress towards achievement of the Millennium development goals(MDG4andMDG7) At the end of the Millennium Development Goals (MDG) in 2015, the development policies emphasized reducing the percentage of people living in households lacking a sustainable environment in terms of durable housing structure, sufficient living area, access to safe water and access to improved sanitation. As a part of Goal 3 of the Sustainable Development Goals (SDG), the UN is aiming to end epidemics of water-borne and other communicable diseases by 2030. Goal 6 emphasizes ensuring the availability of water and sanitation for all.(Organization, 2016)

1.2 Rationale:

Diarrhea and ARI are the leading causes of burden of disease in children worldwide. In Bangladesh of one-fifth of all deaths of under-five children respectively pneumonia, acute respiratory infections (ARIs), and diarrheal diseases, which are related with household environment [BDHS,2011]. Currently very few study on the household environmental risk factors of diarrhea and ARI in children in Bangladesh at national level. And previously no study has been found using MICS survey regarding household environmental factors related children under 5 years' morbidity Moreover, Bangladesh MICS is expected to contribute to the evidence base of several other important initiatives, including Committing to Child Survival, a global movement to end child deaths from preventable causes. In addition, there has been few studies are done to identify the association between the household environmental risk factors with Diarrhea and Acute respiratory infection in Bangladesh at national level using MICS survey. The Bangladesh MICS collected data which is important for monitoring the situation and survival of children in the country. This report has published with limited analysis, leaving a lot of useful information still lying in the data. In this study further analysis of the MICS data will be done with the aim of exploring the household environmental risk factors associated with under 5 leading two morbidities. The understanding the effect of the household's environmental conditions on both ARI and diarrheal disease and its potential differential effect on the risk of mortality during the course of the child's development helps to improve policy formulation and interventions related specifically to housing and environmental conditions in Bangladesh.

1.3 Research objective:

General objective

To find out the child's demographic factors household socio-demographic factors and household environmental factors that are significantly associated with both ARI and Diarrhea among children under 5 years in Bangladesh.

Specific objective

1. Identify the association between child demographic factors and ARI among children under 5 years in Bangladesh
2. Identify the association between household socio-demographic factors and ARI among children under 5 years in Bangladesh
3. Identify the association between household environmental factors and ARI among children under 5 years in Bangladesh
4. Identify the association between child demographic factors and Diarrhea among children under 5 years in Bangladesh

5. Identify the association between household socio-demographic factors and Diarrhea among children under 5 years in Bangladesh
6. Identify the association between household environmental factors and diarrhea among children under 5 years in Bangladesh

1.4. Research Question

What are the child's demographic factors, household socio-demographic factors and household environmental risk factors that are significantly associated with ARI and Diarrhea among children under 5 years in Bangladesh?

1.5 Research hypotheses

1. There is an association between child's demographic factors and with ARI and Diarrhea among children under 5 years in Bangladesh
2. There is an association between household socio-demographic factors and with ARI and Diarrhea among children under 5 years in Bangladesh
3. There is an association between household environmental factors and with ARI and Diarrhea among children under 5 years in Bangladesh

1.6 Conceptual Framework

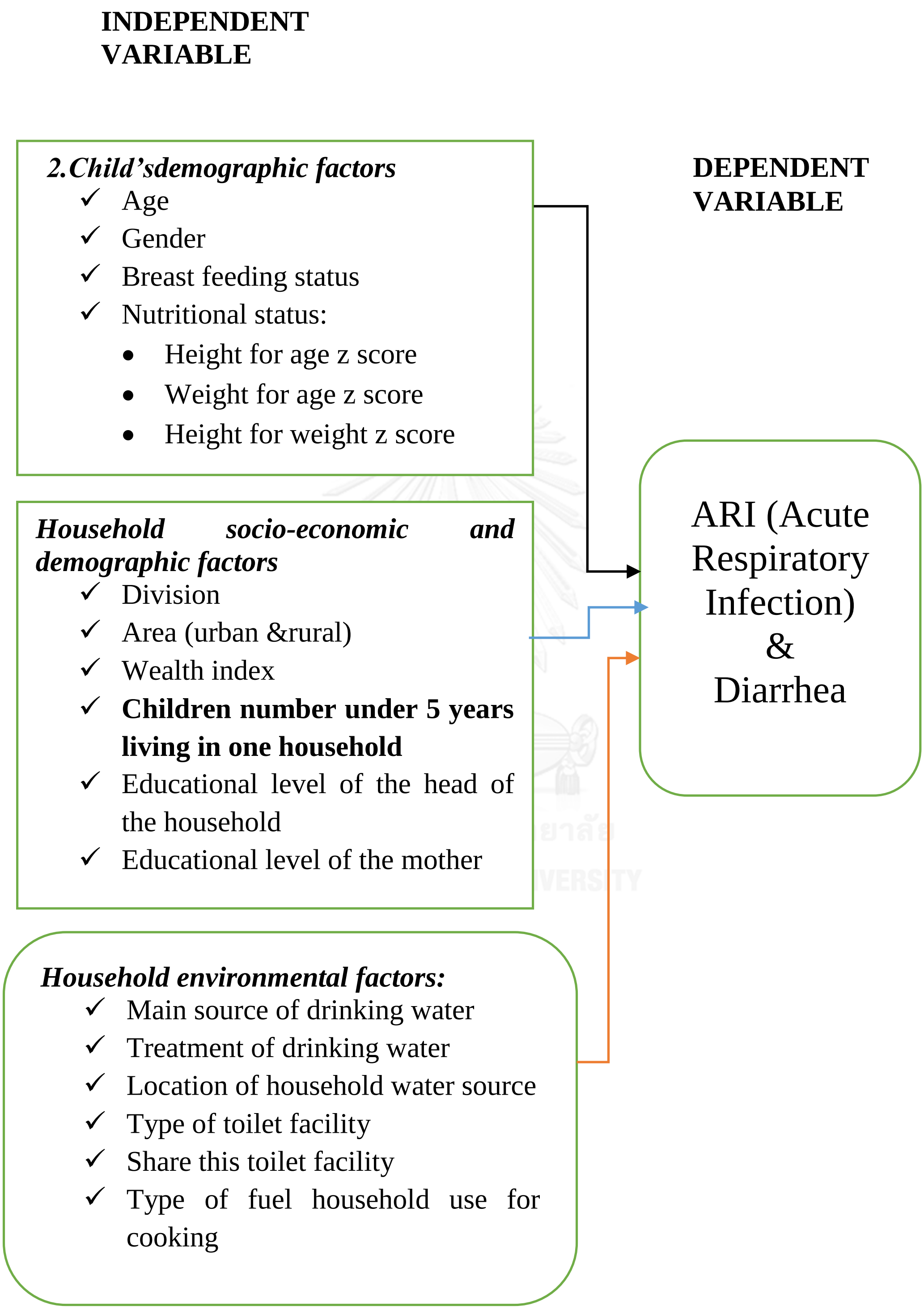

Figure 1 CONCEPTUAL FRAMEWORK

1.7 Operational definitions

The operational definition of the variables in this study are mainly defined based on the UNICEF Multiple Indicator Cluster Survey (MICS) definitions by Bangladesh Bureau of Statistics (BBS) Bangladesh in collaboration with the Ministry of Health, 2012-2013.

House hold socio-demographic and economic factors:

- **Division**. It refers to one of the division of Bangladesh
- **Area** refers to the location of a household. It is classified as either urban or rural.
- **Household wealth index** refers to the economic level of the household. The households were classified as poor, middle class and rich. It is a compound indicator of wealth based on UNICEF. It is calculated based on information of the ownership of consumer goods, dwelling characteristics, water and sanitation, and other wealth related of a household.

- **Educational level of the head of household:** refers to the highest level of school joined by the head of household. It could be none, primary (incomplete and complete), secondary (incomplete and complete) or higher.
- **Number of children in different ages living in household:** referred to total number of Childs were less than 5 years as at last birthday during the interview

- **Maternal education level** referred to highest level of education completed; classified as none, primary, secondary (complete or incomplete).

Household environmental factors:

- **Main source of drinking water**: is classified as water piped into dwelling, compound, yard or plot and neighbor, Public tap/standpipe, Tube well/borehole, Elevated tank, hand pump, Protected and unprotected well, Protected and unprotected spring, Filtered and unfiltered Rainwater collection, Tanker truck and cart with small tank /drum, surface water (river, stream, dam, lake pond, canal, irrigation channel) and Bottled water.
- **Treatment of drinking water** refers to whether the household treats water to make it safe to drink. It is classified as yes or no. Water for drinking was considered treated when the following procedures of treatment were followed: boiling, adding bleach or chlorine, solar disinfection, Use water filter. Water Strained through a cloth, let it stand and settle and using other methods.
- **Location of water source: refers** as Inside own yard which were inside own dwelling &inside own yard / plot and Outside own yard.

- **Type of toilet facility**: was classified as improved or unimproved sanitation facility. Improved facilities included flush// pour flush connected to a sewage system, septic tanks or pit latrines; and to unknown place, ventilated improved pit latrine, composting toilet and pit latrines with slabs. Unimproved facilities included use of flush / pour flush to rivers or canals, pit latrines without slabs or open pit, hanging toilet, no facilities (using bush or field).

- **Share this toilet facility**: refers as shared with other households only (not public) or not shared.

- **Type of fuel used for cooking**: This was classified as clean or pollute fuels. Clean included electricity, liquefied petroleum gas and biogas. Pollute fuel included kerosene, charcoal, coal, wood or agricultural crop residue and animal dung.

Child socio-demographic factors:

- **Age:** Child's age referred to age in completed months at the time of survey

- **Gender:** this refers to being either female or male.

- **Breastfeeding status** refers to children who ever receive breast milk or never breastfed.

Nutritional status:

- Height for age z-score is a nutritional status indicator of height and age of a child expressed in standard deviations from the median of the WHO reference population. This was classified as less than-3 standard deviations (severely stunted), -3 to-2 standard deviations (stunted) and -2 or more standard deviations (normal).

- Weight for age z-score is a nutritional status indicator of weight and age of a child expressed in standard deviations from the median of the WHO reference population. This was classified as less than -3 standard deviations (severely underweight)-3to -2 standard deviations (underweight) and -2 or more standard deviations(normal).

- Weight for height z-score is a nutritional status indicator of weight and height of a child expressed in standard deviations from the median of the WHO reference population. This was classified as less than -3 standard deviations (severely wasted) -3 to-2 standard deviations (wasted), -2 to 2 standard deviations (normal) and more than 2 standard deviations (overweight).

Children under 5 years' diarrhea and acute respiratory infection

- **Diarrhea** was defined as passage of 3 or more loose stool a day or blood in the stool in the last two weeks as reported by the caretaker/mother.
- **Acute respiratory tract infection** was those who had an illness characterized by a cough, accompanied by rapid or difficult breathing in the past two weeks preceding the survey as reported by the caretaker/mother

CHAPTER II

LITERATURE REVIEW

2.1 Global burden of childhood pneumonia and diarrhea

Acute diarrheal and respiratory infections are the most frequent childhood illnesses and causes of attendance at health services in low-income and middle-income countries. Diarrhea and pneumonia remain the leading infectious causes of death in children younger than 5 years, and caused an estimated 700 000 and 1·3 million deaths, respectively, in 2011 .Despite large reductions in child mortality between 2000 and 2010 (both all-cause mortality, and that specifically associated with diarrhea and pneumonia), these diseases remain major causes of avoidable deaths and account for about 30% of all child deaths worldwide The greatest proportions of severe episodes of diarrhea and pneumonia were in the southeast Asian (26% and 39%, respectively) and African regions (26% and 30%, respectively). The global burden of incidence and severe disease for both diarrhea and pneumonia is highest in southeast Asia and Africa(Walker et al., 2013)

The burden of disease is mainly in younger age groups; 72% of deaths from diarrhea and 81% of deaths from pneumonia happen in children younger than 2 years. Pneumonia incidence falls less rapidly with age than does mortality from the disease. Diarrhea incidence peaks at age 6–11 months and then decreases with age (Fischer Walker, Perin, Aryee, Boschi-Pinto, & Black, 2012) studies with information about sex the incidence of diarrhea, which showed significantly more cases in boys than in girl’s community-based studies had sex-specific data for pneumonia incidence, which was higher in boys than in girls (Walker et al., 2013)

Risk relations between specific water and sanitation risk factors (unwashed hands and poor water quality) and diarrhea morbidity and mortality have been shown, but for some outcomes, such as inappropriate excreta disposal, poor availability of evidence permits only rough estimates of risk. Crowding and exposure to indoor air pollution increase pneumonia incidence, but are not associated with increased risk for diarrhea morbidity or mortality. Exposure to indoor air pollution from solid fuel combustion increases the incidence of pneumonia by 80% (Walker et al., 2013)

In Ghanaian children, a time-to-event analysis showed that, as the daily prevalence of diarrhea increased, the risk of a subsequent acute lower-respiratory-tract infection increased by 1·08 (95% CI 1·0–1·15) per day of diarrhea. n a similar analysis of two cohorts, one of Indian and the other of Nepali children, Fischer Walker and coworker reported that, as the number of days with diarrhea increased, the incidence of acute lower-respiratory-tract infections increased. Acute lower-respiratory-tract infections were only a risk factor for diarrhea in a stratified subgroup of infants younger than 6 months (Walker et al., 2013)

Diarrhea and ARI with children under five in Bangladesh:

According to UNICEF data, 15 % under 5 children died due to acute respiratory infection and 6% children died due to diarrhea in 2015. (UNICEF, 2016)

WHO reported in the year 2013, Bangladesh had 6 %under five deaths due to diarrhea and 14% death due to ARI in children under five years and 1/5th of all deaths respectively acute respiratory infection and diarrhea, which are related with household environment. (Kamal, Hasan, & Davey, 2015; Organization, 2015)

2.2 Child factors associated with diarrhea and ARI in children under 5 years

A number of child factors are associated with an increased risk of diarrhea and ARI. These include age, sex, and breastfeeding status Children aged <2 years are generally more vulnerable to infections including diarrhea and respiratory infection as supported by previous studies in developing countries (Takanashi et al., 2009). globally in 2010, estimate that about 19 million episodes of severe ALRI occurred in children aged 0–59 months (Nair et al.) ALRI were more than three times higher in neonates and about 1·3 times higher in infants aged 0–11 months than the overall rate in young children aged 0–59 months(Nair et al.) (Hasan & Richardson, 2017)

Multiple studies identified increase risk of diarrhea with younger age, male gender,(Kalakheti, Panthee, & Jain, 2017) Another systematic reviews have shown that ALRI in children are overall both more frequent and severe in males compared to females (Sonego, Pellegrin, Becker, & Lazzerini, 2015) Another study compared that female sex was associated with a significantly 15% increased odds of mortality from ALRI (Sonego et al., 2015) Findings from 28 unpublished studies show that the incidence of admissions for severe ALRI was higher in boys than in girls for all age groups and regions; this sex difference was greatest in studies from South Asia Although this increased risk could be attributable to the smaller airway size in young boys than in young girls, but in South Asian studies (India, Pakistan, and Bangladesh) probably shows the importance of cultural factors, such as preference in seeking medical care for boys(Nair et al.) Male children, those who had a low birth weight, and those aged 7 to 36 months are more likely to have a diarrheal morbidity compared with female children and those who had a normal birth weight.(Bado, Susuman, & Nebie, 2016) . Younger children possess significantly higher risks of experiencing morbidity than older; the result is consistent with previous studies in Bangladesh and elsewhere.(Hasan & Richardson, 2017)

2.2.1 Child's nutritional status associated with diarrhea and acute respiratory infections:

Malnutrition remains one of the most common causes of morbidity and mortality among children throughout the world. Under nutrition consisting of stunting, wasting, and deficiencies of vitamin A and zinc, along with sub optimum breastfeeding

(Hegde & Gaur, 2017).Diarrhea has been an established cause as well as effect of malnutrition. Diarrheal illnesses impair weight as well as height gains, with the greatest effects being seen with recurrent illnesses, which reduce the growth which occurs after diarrheal illnesses or severe malnutrition. Malnutrition leads to increased frequencies and durations of diarrheal illnesses, with a 37% increase in frequency and a 73% increase in duration accounting for a doubling of the diarrhea burden in malnourished children(Kalakheti et al., 2017) The prevalence of diarrhea is 5-7 times more in malnourished as compared to normal children and have long lasting, severe and recurrent diarrhea (Akhter, Alauddin, Rahman, & Chowdhury, 2014) A study in Brazil, indicates that children with low weight-for-age showed over 20% higher risk of having diarrhea (Escobar et al., 2015)

Malnutrition or linear growth retardation are known risk factors of respiratory tract infections (Kinyoki et al., 2017a) Malnourished children had considerably shown immunity impairment, especially cellular immunity deficiency. Hence they become more prone to ARI/ALRI. Malnourished unvaccinated children had higher risks of ARI in children (younger than 2 years old) and severe malnutrition 1.85 times (95 percent CI: 1.14-3.0) increased the risk of ARI in under-five year old children(Yellanthoor & Shah, 2014)

The interaction between diarrhea and undernutrition also severely compromises child immune functions, not only favoring the occurrence of new episodes of the illness, but also contributing to increased risk of other infectious diseases, such as pneumonia(Walker & Black, 2007)In addition, persistent diarrheal diseases may lead to acute malnutrition, which in turn increases the risk of ARI(Kinyoki et al., 2017a).There are several pathways that may explain the amplification of risks arising

from the interaction between undernutrition, diarrhea, and acute respiratory disease. For example, a child may start with diarrhea and evolve towards acute malnutrition, finally contracting pneumonia, or, conversely, begin with a respiratory infection that worsens with an acute episode of diarrhea or sequential infections, the interaction between diarrhea and pneumonia, aggravated by malnutrition. (Escobar et al., 2015).

2.2.2 Child's feeding practices associated with diarrhea and respiratory infections

Infant and young child feeding is a key area to improve child survival and promote healthy growth and development. The first 2 years of a child's life are particularly important, as optimal nutrition during this period lowers morbidity and mortality, reduces the risk of chronic disease, and fosters better development overall. Optimal breastfeeding is so critical that it could save the lives of over 800 000 children under the age of 5 years each year.(Victora et al., 2016)

In 1984, a comprehensive review indicated that promotion of breastfeeding was one of the most important interventions for controlling diarrhea and acute respiratory infection among children. Breast milk contains immune cells, antibodies, immune modulators and growth modulators that protect the child against respiratory infection. Several mechanisms for a possible protective effect of breastfeeding against gastrointestinal infections, including the presence of substances with antimicrobial or immunological properties in breast milk , avoidance of contamination (as in non-human milk or baby bottles) Furthermore, in low-income settings breastfeeding can reduce the risk of undernutrition due to repeated infections and use of improper weaning foods (WHO, 2013)

Most studies have demonstrated the multiple benefits of breastfeeding generally and particularly exclusive breastfeeding in reducing morbidity in children. It was estimated that promotion of breastfeeding would reduce diarrhea morbidity by 8% to 20%,Breastfeeding reduced the risk of death for respiratory infection by 70% depending on different assumptions, and mortality would decrease by 24 to 27%.(WHO, 2013) In recent years, an increasing number of studies have reported on the benefits of the breast milk and optimal breastfeeding practices for the mother-infant pair. These benefits include lower risk for infectious diseases (e.g. diarrhea, ARI) U5M higher intelligence for the infant (Ogbo et al., 2017) Compared with exclusive breastfeeding in the first few months of life ,with partial or no breastfeeding was associated 4 time increasing diarrheal death (Kalakheti et al., 2017).

In a 12-month cohort study among 1677 infants who were born in slum areas of Dhaka in Bangladesh, infants who were either partially or not breastfed had a higher risk of post neonatal death than infants who were breastfed exclusively for the first 4 months of life. The hazard ratio estimates for ARI and diarrhea deaths were 2.40 and 3.94 among partially or not breastfed infants, compared with exclusively breastfed infants(Arifeen et al., 2001)

2.3 Household socio demographic factors associated with diarrhea and respiratory infections in children under 5 years

Wealth index was used to evaluate the influence of social class on fertility behavior and health of mother and child. Poverty influences health because it largely determines environmental risks, as well as access to resources to deal with those risks. Improvements in economic status reduce health risks especially for children whose mothers have better acquired knowledge and breastfeeding reduces risk of both diarrhea and ARTIs(Agustina et al., 2015; Ogbo et al., 2017) another important aspect of diarrhea determination among Indigenous children was the association with number of household residents

Parental educational status is observed as a key determining factor in childhood morbidity in developing countries(El Gilany & Hammad, 2005) this findings is contradict with the studies done in Zimbabwe and Bangladesh (Kamal et al., 2015; Root, 2001)

Maternal education was found to have a protective effect against childhood illness(Aluisio et al., 2015) Mother's education is important because it facilitates her integration into a society impacted by traditional customs, colonialism, and neo-colonialism. That is, an educated woman has the ability to utilize all available information and resources effectively which reduces the risk of child morbidity and mortality(Hossain, 2015) literate mothers are more likely to have more information about health care facilities and provide their children a healthy environment and nutritious food than illiterate mother(Amal K Halder & M Kabir, 2008)Another study supports same evidence of marked reduction of diarrhea in children among more educated mothers(Agustina et al., 2015) A systematic analysis estimated that Lower maternal educational level was significantly associated with ALRI in175 countries (Sonego et al., 2015)

2.3.1 Household indoor pollution with acute respiratory infections in children under 5 years

Previous systematic reviews have reported on the association between pneumonia mortality in children and single risk factors, such as hypoxemia, inadequate breastfeeding and indoor air pollution from solid fuels .(Sonego et al., 2015) Household air pollution (HAP) from cooking fuel is a substantial cause of respiratory illness and death and remains a major public health concern in the developing world(Naz, Page, & Agho, 2017).

Globally, more than three billion people depend on solid fuels (wood, animal dung, crop residues, charcoal and coal) for cooking and heating and, in the case of rural populations, approximately 90% households use biomass fuels as their primary source of domestic energy(Naz, Page, & Agho, 2015) (Felix & Gheewala, 2011) The poorest populations of the world are most vulnerable to the effects of household air pollution (HAP), with approximately 4.3 million deaths worldwide has been attributable to HAP in 2012 [WHO 2012).

HAP has a disproportionately adverse effect on the health of women and children under five years of age, particularly acute respiratory infections (ARI) (Naz et al., 2015) children are more vulnerable to air pollution than adults because of their higher oxygen consumption rate for which they inhale more pollutants and also for the fact that their airways are narrower which results more irritation for greater airway obstruction However, young children are at greater risk of exposure from cooking fuel than older children as they spend more time indoors (Naz et al., 2015) Approximately 86% of the population still rely primarily on solid fuels as a domestic source of energy, particularly in rural households (Bangladesh Demographic and Health Survey (2011) . Using solid fuel for cooking is a major source of household air pollution and responsible for a variety of respiratory diseases.(Hasan & Richardson, 2017)

Around 3.6% of the total burden of disease in the country has been attributable to HAP and 21% of deaths among children <5 years are associated with ARI (Baqui et al., 2001). pneumonia is still the leading single cause of under-five deaths in Bangladesh, accounting for one-fifth of all deaths (Bangladesh Demographic and Health Survey,2011)

2.3.2 Safe drinking water, sanitation, and hygiene with diarrhea and in children under 5 years

Sourcing water from unimproved sources and poor sanitation practices have been implicated in the death of a child every 15 s from diarrhea disease. According to the WHO, diarrhea, annually accounts for 1.7 million morbidities and 760, 000 under-five children's deaths globally. It remains the second leading cause of death among children under-five globally (Adebowale, Morakinyo, & Ana, 2017).

Among 88% of diarrheal cases are related to unsafe water, inadequate sanitation, or insufficient hygiene (Prüss-Ustün et al., 2014). Because of unsafe water, inadequate sanitation or insufficient hygiene causes repeated diarrhea or intestinal nematode infections results 50% of underweight or malnutrition of children (Bartram

& Cairncross, 2010)Despite MDG progress, still 2.7 billion people will have no basic sanitation and 672 million people will be living without access to improved water sources even though the MDG meets by 2015 .Children are more susceptible to poor outcomes from diarrhea--such as life-threatening dehydration .Diarrhea can also contribute to under-nutrition through mal-absorption. Diarrhea, along with nematode infections caused by poor sanitation, can lead to 3.5 million under-five child deaths per year(Prüss-Üstün, Bos, Gore, & Bartram, 2008) A World Bank publication found that in the absence of diarrhea, the nutritional status of those who are undernourished improves quickly(June J Cheng, Corinne J Schuster-Wallace, Susan Watt, Bruce K Newbold, & Andrew Mente, 2012).

This pattern of findings can be explained in several different ways. Access to clean water is essential for mothers who do not breastfeed; the use of dirty containers and unsafe water for formula preparation puts infants' health at risk. Infants who are not breastfed are six times more likely to die from infectious diseases, including diarrhea, in the first 2 months of life than those who are breastfed(June J. Cheng, Corinne J. Schuster-Wallace, Susan Watt, Bruce K. Newbold, & Andrew Mente, 2012).

In addition, many basic birth practices, including hand washing, can affect infant mortality outcomes(Rhee et al., 2008). More developed communities are more likely to have better sanitation connections, which improve infant survival. (Jones G, Steketee RW, Black RE 2003). The consistent use of hygienic latrines has been shown to protect individuals from enteric diseases In Bangladesh, hygienic latrines are not available free of charge (Amal K. Halder & M. Kabir, 2008) A study in Nepal shows having not shared toilet ,using treated water and practicing hand washing before feeding has positive relation with less number of diarrhea(Kalakheti et al., 2017)Another study conducted by Bhatnagar in Nepal pointed out that untreated water and unsafe feces disposal has positive relation with diarrhea(Kalakheti et al., 2017) The positive effect of child's stool disposal is supported by another study ,it says that improved excreta disposal is effective in preventing diarrheal disease (Clasen et al., 2010).

CHAPTER III

METHODOLOGY

This study used secondary data from the Bangladesh Multiple Indicator Cluster Survey that was conducted in 2012-2013 by the Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Bangladesh in collaboration with the Ministry of Health as part of the global MICS program which is technically and financially supported by UNICEF. The data sets used for the secondary analysis by requesting the official website of UNICEF that deals with global MICS, http://mics.unicef.org/surveys .

3.1 Study design

Bangladesh MICS data collected through a cross -sectional study design.

3.2 Study area

Data collection was done in all the seven divisions and sixty-four districts of Bangladesh

3.3 Study population

The study population of this research were children who were under five year of age during the Bangladesh MICS 2012-2013.

3.4 Sampling technique

The primary objective of the sample design for the Multiple Indicator Cluster Survey (MICS) was to produce statistically reliable estimates of most indicators, at the national level, for urban and rural areas, for the seven divisions, and for the sixty-four districts of the country. Districts of the country were defined as the sampling strata. The survey was based on a two-stage stratified sample of households. The 2011 census frame was used for the selection of clusters. Census enumeration areas (EAs) were defined as primary sampling units (PSUs), and were selected from each of the sampling strata using a probability proportional to size (PPS) sampling procedure, based on the number of households in each enumeration area from the population and housing census 2011 frame. The survey is based on a two-stage stratified sample of house.

Stage 1

Bangladesh
Seven division
District (name as main sampling strata)
In each stratum, specified number of census enumeration areas(cluster) for both in urban and rural area were selected.
Within the selected enumeration areas household listing was carried out

Figure 2 STAGE 1

Within the seven division the districts were identified as the main sampling strata. Within each stratum, a specified number of census enumeration areas(cluster)were selected systematically with probability proportional to size (pps). EAs/(PSUs) were selected with probability proportional to the EA size, in urban areas and in rural areas. A complete household listing operation was then carried out in all of the selected EAs to provide a sampling frame for the second-stage selection of households.

Stage 2

From each sample enumeration area
20 households were selected by random systematic sample

Figure 3STAGE 2

A random systematic sample of 20 households was drawn in each sample enumeration area, a systematic sample of 20 households on average was selected per EA to provide statistically reliable estimates of key demographic and health variables for the country as a whole, for urban and rural areas separately, and for each of the seven divisions.

- Four (04) of the selected enumeration areas were not visited because they were inaccessible due to rough weather and hilly remote road communication during the fieldwork period.

Sample size

With this design, the MICS survey. there were 23,402 children under age five listed in the household questionnaires. Data were completed for 20,903 of these children, which were selected as sample population in secondary analysis.

3.6 Measurement tools

Four sets of questionnaires were used in the survey. this secondary study used 2 sets questionnaires
1) A household questionnaire which was used to collect information on all de jure household members (usual residents), the household, and the dwelling;

3) An under-5 questionnaires, administered to mothers (or caretakers) for all children under 5 living in the household; and

From the MICS5 pilot English version, the questionnaires were translated into Bengali The questionnaires are based on the MICS5 model questionnaire3 tested during the global MICS5 pilot study in Sirajganj and Bogra during May-June 2012. From the MICS5 pilot English version, the questionnaires were translated into Bengali and tested during the global MICS5 pilot. Based on the results of the pre-test, modifications were made to the wording and translation of the questionnaires.

3.7 Data collection

Before data collection, a 14 days training program was provided in November 2012 by the MICS coordinators. Training for the fieldwork was conducted for 14 days in November, 2012. Training included lectures on interviewing techniques and the contents of the questionnaires, and mock interviews between trainees to gain practice in asking questions. Towards the end of the training period, trainees spent 2 (two) days in practice interviewing in Dhaka and Narayanganj.

The data were collected by 32 teams; each was comprised of four (04) female interviewers, one editor, one measurer and a supervisor.
Fieldwork began in December, 2012 and concluded in April, 2013.

3.8 Inclusion criteria

All children under five -year-old were included with in the study.

3.9 Exclusion criteria

Missed data on important variables were excluded from analysis.

3.10 Data analysis

In this secondary analysis were done by extracting data from 4 dataset of the MICS Bangladesh survey 2012-2013., (, children data set and household data set) were obtained from UNICEF. Statistical Package for Social Sciences (SPSS) software program version 16 were used for this analysis the and. most of independent variables and the dependent variable were found or computed in the, children data set, household data set.

Data set merging

Variables of interest will be added through merging with the data set that contained the variable (s) of interest. The cluster number, household number and individual line number were computed to form a unique person identification numbers in each data set which formed the basis upon which merging were done.

Statistical Analysis:

In the secondary analysis, data were extracted from the MICS 2012-2013 Bangladesh, four data sets (children data set, household data set). The Statistical Package for Social Sciences (SPSS) software program, Version 16 were used to merge variables from 2 datasets (child and household datasets) and for final analysis.

Frequencies and percentages were calculated for data on each variable in descriptive analysis

Bivariate were computed using binary logistic regression and Multivariate analysis were computed using binary logistic regression since outcomes are dichotomous to find the adjusted odds ratio and were reported by p-values and 95% CI. P-value less than 0.05 were considered as statistical significant. In bivariate analysis each independent variable was analyzed individually with the both dependent variables separately.

Both ARI and diarrhea were investigated separately using logistic regression models. Groups of variable in different categories (child's factors / household factors) were used in model analysis.

- In model 1, the child's factors and were analyzed separately with each of the dependent variables (ARI and diarrhea)
- In model 2, the household socio economic & demographic factors, were analyzed separately with each of the dependent variables (ARI and diarrhea)
- In model 3, the household environmental factors, were analyzed separately with each of the dependent variables (ARI and diarrhea)
- In model 4. The child socio–economic &demographic factors and household environmental factors, were analyzed separately each of the dependent variables (ARI and diarrhea)
- In model 5, All 4 groups including, household socio- economic demographic actors, household environmental factors, and child's factors were analyzed separately with each of the dependent variables (ARI and diarrhea)

3.10 Ethical consideration

The study protocol was submitted to the Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University for ethical approval.

3.11 Beneficiaries

The results of this study could contribute in the efforts of achieving the target of the Millennium Development Goals of reducing the environmental related under-five morbidity and mortality in Bangladesh.

3.12 Study Period

The primary study was carried out from December, 2012 to April, 2013. This secondary study was conducted between February 2017 and July 2017

CHAPTER IV

RESULTS

This chapter presents the results of the study under the following parts.

1. General characteristics which include

    - Demographic characteristics, nutritional status and feeding patterns of children aged less than 5 years.
    - Socio-demographic and economic characteristics of household of children under 5 years.
    - Household environmental characteristics of children under 5 years.

2. Bivariate analysis of factors associated with ARI in children using binary logistic regression.
3. Multivariate analysis of factors associated with ARI in children using binary logistic regression.
4. Bivariate analysis of factors associated with diarrhea in children using binary logistic regression
5. Multivariate analysis of factors associated with diarrhea in children using binary logistic regression

4.1.1 Children's demographic characteristics:

Male children were slightly more (51.3%) than female children. Children aged less than 23 months were 37.9% and 62.1 % children were aged between 24-59 months. Majority of children aged less than 5 years had ever breastfed that is 98%.

Nutritional status was assessed through 3 parameters: height for age, weight for age and weight for height z score.

Considering height for age z score, 15.3% of children had a z score of less than -3 signaling severe stunting; 23.8% were stunted (z score of -3 to -2.0 As for weight for age z score, 8.5 % of children had a score below -3 (severely underweight) while 22.4% had a score of between -3 and -2.01 (underweight).

As for the weight for height, 1.7% of children had z score of less than -3 (severely wasted) with 7.6 % having a z score of between -3 and -2.00 (wasted). About 1.4 % of children had a z score of more than 2(overweight).

Table 1. below summarizes demographic characteristics of children aged less than 5 years in Bangladesh.

Table 1: Demographic characteristics of children aged less than 5 years in Bangladesh. (n=20903)

Characteristics	Number	%
Sex		
Male	10732	51.3
Female	10171	48.7
Age in months		
0-5 months	1959	9.4
6-11months	1942	9.3
12-23months	4026	19.3
24-35months	4175	20
36-47months	4391	21
48-59months	4410	21.1
Breast feeding status		
Breastfed	20480	98
Never breastfed	411	2
Height for age z score		
<-3	3203	15.3
-3 to -2.01	4984	23.8
≥-2	11203	53.6
Missing	1512	7.2
Weight for age z score		
<-3	1779	8.5
-3 to -2.01	4676	22.4
≥-2	13465	64.4
Missing	982	4.7
Weight for height z score		
<-3.00	353	1.7
-3 to -2.01	1588	7.6
-2.00 to 2.00	17354	83
>2.00	302	1.4
Missing	1305	6.2

4 .1.2 Household socio-demographic and economic characteristics

About 84.1 % of children that participated in the study were from households located in rural areas. Most of the children were from Dhaka division (25%) with having the least number of children in Sylhet division, Barisal division, and Rajshahi division.

Majority number of children belonging to middle class wealth index that is 56 % while 14% belonged to the rich and 30 % belonged to poor wealth index quintile households. Majority of children belonged to households whose head had no education (42%).

But majority of mother (45%) of the children had secondary or high education level and 25.1 % had no education. Maximum household (70 %) had only one child, rest of the household had more than one children aged under 5 in each household.

Table 2. below summarizes household characteristics of children aged less than 5 years in Bangladesh.

Table 2 Household socio-demographic and economic characteristics of children aged less 5 years in Bangladesh. (n=20903)

Characteristics	Number	%
Area		
Urban	3331	15.9
Rural	17572	84.1
Division		
Barisal	1929	9.2
Chittagong	4343	20.8
Dhaka	5235	25
Khulna	2729	13.1
Rajshahi	1996	9.5
Rangpur	2639	12.6
Sylhet	2032	9.7
Household wealth index		
Poor	6264	30
Middle	11703	56
Rich	2936	14
Educational level of household head		
None	8778	42
Primary completed	5752	27
Secondary or higher completed	6352	30
Missing	21	0.1
Education level of mother /caretaker		
None	5255	25.1
Primary completed	6253	29.9
Secondary or higher completed	9395	45
Total number of children under 5 in each household		
1 Child	14624	70
>1 Child	6279	30

4 .1.3 Household environmental characteristics

Majority of children (95.3%) belonged to household that used drinking water from safe sources. Almost 95.1% of children belonged to households that do not treat water to make it safe for drinking. The water source distribution of these household are 65.3 % are inside yard and 32.2% are outside yard. A majority (70%) of children belonged to households with improved toilet facility. Almost 30% shared the toilet facility with other households. Most children (92.7%) belonged to household that use pollute fuels for cooking

Table 3: Household environmental characteristics of children aged less 5 years in Bangladesh.

Characteristics	Number	%
Main source of drinking water		
Safe source	19913	95.3
Unsafe source	989	4.7
Treat water to make safe for drinking		
Yes	1026	4.9
No	19868	95.1
Location of drinking water source		
Inside own yard	13657	65.3
Outside yard	6790	32.5
Missing	456	2.2
Types of toilet facility		
Improved	14720	70.4
Unimproved	6176	29.6
Shared toilet facility		
Shared	6299	30.1
Not shared	13394	64
Missing	1210	5.7
Types of cooking fuel		
Clean fuel	1048	5
Pollute fuel	19370	92.7

4 .1.4 Acute respiratory infection and diarrheal characteristics of children aged less 5 years in Bangladesh

About 15.6 % children under 5 years had acute respiratory infection (ARI) and 0.4 % Children had diarrhea.

- Diarrhea was defined as passage of 3 or more loose stool a day or blood in the stool in the last two weeks as reported by the mother /caretaker.
- Children with acute respiratory tract infection were those who had an illness characterized by a cough, accompanied by rapid or difficult breathing in the past two weeks preceding the survey as reported by the mother /caretaker

Table 4**:** Acute respiratory infection and diarrheal characteristics of children aged less 5 years in Bangladesh.

Characteristics	**Number**	**%**
Acute Respiratory Infection		
Yes	3260	15.6
No	17643	84.4
Diarrhea		
Yes	829	4
No	20074	96

4.2. Bivariate analysis of factors associated with acute respiratory infection (ARI) of children less than 5 ears in Bangladesh**.**

Bivariate analysis was done by using binary logistic regression, where each independent variable was independently anal sized with dependent variable ARI.

4.2.3Association between household child demographic factors associated with ARI in children aged less than 5 years in Bangladesh.

Age of the child had a significant positive association with ARI (p =.000). The odds ratio (OR) suggests that children in household with 0-5 months were 1.4 times, 6-11months were 1.8 times ,12-23 months 1.7 times ,24- 35months were 1.4 times and 36-47 months were 1.2 times more likely to develop ARI than children of 48-59 months.

There was no statistically significant association between ARI and child sex, breast feeding status and nutritional status overall as shown in table below

Table 5**:** Bivariate analysis of child demographic factors associated with ARI in children aged less than 5 years in Bangladesh

Variables	B	Unadjusted OR	95% CI
Sex **P=.561**			
• Male	0.022	1.022	0.949-1.102
• Female		1	
Age **P=<.001**			
• 0-5months	0.362	1.436	1.235-1.670
• 6-11months	0.576	1.779	1.539-2.056
• 12-23months	0.507	1.660	1.471-1.874
• 24-35months	0.369	1.447	1.280-1.635
• 36-47months	0.185	1.203	1.062-1.362
• 48-59months		1	
Breast feeding status **P=.054**			
• Never breastfed	-0.293	0.746	0.553- 1.005
• Ever breastfed		1	

Table 6**:** Bivariate analysis of child demographic factors associated with ARI in children aged less than 5 years in Bangladesh. (continue)

Variables	**B**	**Unadjusted OR**	**95% CI**
Nutritional status			
Height for age z score P=.342			
• >-3	0.005	1.005	0.901-1.120
• -3 to -2.01	0.067	1.069	0.976-1.171
• ≥-2.00		1	
Weight for age z score P=.390			
• >-3	0.079	1.082	0.947-1.237
• -3 to -2.01	0.350	1.044	0.953-1.144
• ≥-2.00		1	
Weight for height z score P=.579			
• >-3	0.011	1.011	0.699-1.528
• -3 to -2.01	0.014	1.014	0.728-1.412
• -2 to 2	-0.073	0.930	0.685-1.263
• >2		1	

4.2.1 Association between household demographic factors associated with ARI in children aged less than 5 years in Bangladesh.

Division had a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that children in Barisal were 1.5 times, Chittagong were 2.2 times, Khulna were 2.1 times, Rajshahi were 1.2times and Rangpur were 1.6 times more likely to develop ARI than Sylhet division.

Wealth index had as a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that children in poor household had 1.48 times more likely to develop ARI than Rich household.

Education level of household head had as a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that children in household head with primary completed education level had 1.2 times more likely to develop ARI than household head with secondary/higher completed. However, it is not significant in children with household head with no education with ARI.

Total number of children had as a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that household had only one child were 1.69 times more likely to develop ARI than more than one children.

There was no statistically significant association between ARI and area; maternal educational level as shown in table below.

Table 7: Bivariate analysis of household demographic factors associated with ARI in children aged less than 5 years in Bangladesh.

Variables	B	Unadjusted OR	95% CI	
Area				**P=.735**
• Rural	0 .018	1.018	0.919-1.128	
• Urban		1		
Division				**P=<.001**
• Barisal	0.439	1.551	1.290-1.866	
• Chittagong	0.796	2.217	1.896-2.598	
• Dhaka	-0.131	0.877	0.743-1.035	
• Khulna	0.759	2.136	1.808-2.523	
• Rajshahi	0.185	1.204	0.995-1.456	
• Rangpur	0.496	1.642	1.382-1.950	
• Sylhet		1		
Wealth index				**P=<.001**
• Poor	0.393	1.481	1.309-1.677	
• Middle class	0.101	1.106	0.983-1.245	
• Rich		1		
Household head education level				**P=<.001**
• None	0.070	1.072	0.979-1.174	
• Primary completed	0.196	1.217	1.103-1.342	
• Secondary/higher completed		1		
Maternal education level				**P=.480**
• None	0.044	1.045	0.953-1.147	
• Primary completed	-0.016	0.984	0.901-1.076	
• Secondary /higher completed		1		
Number of children under 5 in household				**P=<.001**
• 1 child	0.156	1.169	1.075-1.271	
• >1 child		1		

4.2.2 Association between household environmental factors associated with ARI in children aged less than 5 years in Bangladesh.

Main source of drinking water and location of water source had a significant positive association with ARI (p=0.000). The odds ratio (OR) suggests that children in household with unsafe water drinking water supply were 1.43 times more likely to develop ARI than Safe source of drinking water and water source locating outside the yard were 1.24 times more likely to develop ARI than water source located outside yard.

Types of cooking fuel had a significant positive association with ARI (p =.005). The odds ratio (OR) suggests that children in household with pollute fuel were 1.29 times more likely to develop ARI than clean fuel. There was no statistically significant association between ARI and treatment of drinking water and as shown in table 6 below.

Table 8: Bivariate analysis of Household environmental factors associated with ARI in children aged less than 5 years in Bangladesh.

Variables	B	Unadjusted OR	95% CI
Main source of drinking water			**P=<.001**
• Unsafe source	0.360	1.434	1.223-1.681
• Safe source		1	
Treat drinking water			**P=.66**
• No	-0.038	0.963	0.812-1.142
• Yes		1	
Location of water source			**P=<.001**
• Outside yard	0.218	1.244	1.150-1.345
• Inside own yard		1	
Types of cooking fuel			**P=.005**
• Pollute fuel	0.260	1.297	1.076-1.564
• Clean fuel		1	

4.3 Multi variate analysis: Multivariate analysis of factors associated with ARI in children aged less than 5 years

Binary logistic regression analysis was applied to form 5 models to predict the probability that a child less than 5 years would suffer from ARI. All the independent variables, which were applied to analysis the bivariate had selected as predictors to ARI of child under 5 years.

- In model 1, the child's factors and will be analysis separately with each of the dependent variables (ARI)
- In model 2, the household socio demographic factors, will be analysis separately with each of the dependent variables (ARI)
- In model 3, the household environmental factors, will be analysis separately with each of the dependent variables (ARI)
- In model 4. The child demographic factors and household environmental factors, will be analysis separately each of the dependent variables (ARI)
- In model 5, All 4 groups including, household socio-demographic actors, household environmental factors, mother/caretakers factors and child's factors will be analysis separately with each of the dependent variables (ARI)

4.3.1MODEL 1: Multivariate analysis of child demographic factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh

In model 1, the child demographic factors with ARI were analyzed by binary logistic regression. The child demographic factors were gender, age, breastfeeding status and nutritional status which includes height for age z score, weight for age z score and weight for height z score. While adjusting for other variables and employing less than 0.05 criterion of statistical significant

In model 1, Child's age had a highly significant association with ARI ($p < 0.001$). Children ,0-5 aged were 1.5 times, aged 6-12 months were 1.7 times, aged 12-23 months were 1.6 times and ages 24-35 months were 1.4 more likely to develop ARI than children aged 48-59 months while those aged less 36-47 months were only 1.18 times more likely to develop ARI than those aged 48-59 months.

However, gender of the child, breastfeeding status and nutritional status had no significant effects on ARI.

Table 8 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was significant with $\chi 2$ =106.66, at 10 df and P<0.001 Nagelkerke R square=1.9%, Hosmer & lemeshow test P=0.0949, Classification accuracy =84.3% (shown in model summary)

Table 9: MODEL 1: Multivariate analysis of child demographic factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh.

	Model 1			
Variable	B	OR	95%CI	P value
constant	**-2.106**	**.122**		**0.000**
Child Age				
0-5 months	.439	1.552	1.327-1.814	<0.001
6-11months	.572	1.772	1.524-2.06	<0.001
12-23months	.500	1.648	1.453-1.870	<0.001
24-35months	.390	1.477	1.300-1.679	<0.001
36-47months	.167	1.182	1.036-1.347	0.013
48-59months		1		
Child gender*	**-.036**	**.964**	**0.892-1.043**	**0.363**
**Breast feeding status: ** **	.221	1.247	0.900-1.728	0.185
Nutritional status:				
Height for age	.010	1.011	0.941-1.085	0.773
Weight for age	-.085	.919	0.839-1.007	0.069
Weight for height	.032	1.033	0. 921-1.159	0.582
female as reference, compare with male. ***** ever breast fed as reference , compare with never breastfed***	**Model summary** Chai square=106.66, df=10, p=<0.001 Nagelkerke R square=1.9% Hosmer & lemeshow test P=0.0949 Classification accuracy =84.3%			

4.3.2 MODEL 2: Multivariate analysis of household socio economic and demographic factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh.

In model 2, division had a highly significant association with ARI ($p< 0.001$). Children lived in Chittagong division were 2.16 times, and Khulna division were 2.06 times more likely to develop ARI than children lived in Sylhet division.

Wealth index had a positive significant association with ARI(p=<.001). Children from poor household were 1.46 times more likely to develop ARI than rich household.

Total number of children in one household had a positive significant association with ARI(p=<.001). household had only one child were 1.18 times less likely to develop ARI than household with more than one child.

Education level of household head had a positive significant association with ARI(p=<.001). Children belonged to household where head had primary education were 1.17 times more likely to develop ARI than household where the head had secondary or higher education.

Area and maternal educational level had no significant effects on ARI.

Table 9 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was highly significant with $\chi2$ =435.753, d f=13, p=<0.001 Nagelkerke R square=3.6% ,Hosmer & lemeshow test P=0.051, Classification accuracy =84.4% (shown in model summary)

Table 10: MODEL 2: Multivariate analysis of household socio economic and demographic factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh.

	Model 2			
Variable	B	OR	95%CI	P
constant	**-2.456**	**.086**		**0.000**
Area	.006	1.006	.902-1.122	.916
Division				
Barisal	.361	1.434	1.188-1.731	<.001
Chittagong	.770	2.160	1.844-2.530	<.001
Dhaka	-.139	.870	.735-1.029	.104
Khulna	.726	2.067	1.743-2.453	<.001
Rajshahi	.139	1.150	.947-1.396	.159
Rangpur	.438	1.550	1.301-1.846	<.001
Sylhet		***1***		
Wealth index				
Poor	.383	1.467	1.264-1.702	<.001
Middle class	.109	1.116	.979-1.271	0.1
Rich		1		
Total number of under 5 children in household* ****>1 child as reference compare to 1 child***	.165	1.180	1.082-1.286	<.001
Household head's education level				
None	.021	1.021	.917-1.137	.704
Primary completed	.159	1.172	1.055-1.302	.003
Secondary /higher completed		1		
Maternal education level	.037	1.038	.981-1.098	.200

4.3.4. MODEL 3: Multivariate analysis of household environmental factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh.

In model 3, main source of household drinking water had a positive significant association with ARI(p=0.016). Children belonged to household used unsafe water source as a source of drinking water were 1.123 times more likely to develop ARI than household used safe water source as a source of drinking water.

Location of the water source location had highly significant association with ARI (P=<.001). Children belonged to household used water source outside yard were 1.21 times more likely to develop ARI than household used water source inside own yard as a source of drinking water.
Treatment of water and type of cooking fuel had no significant effects on ARI.

Table 10 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was highly significant with $\chi 2$ = 147.966, d f=14, p=<0.001, Nagelkerke R square=1.4%, Hosmer & lemeshow test P=0.176,Classification accuracy =84.3%(shown in model summary)

Table 11: MODEL 3 : Multivariate analysis of household environmental factors associated with acute respiratory infection (ARI) in children aged under 5 years in Bangladesh.

	Model 3			
Variable	B	OR	95%CI	P
constant	**-1.770**	**.170**		**0.000**
Main source of drinking water* ***safe water source as reference compare to unsafe source***	.214	1.238	1.040-1.473	0.016
Treat drinking water	**-.091**	**.913**	**.750-1.112**	**0.364**
Location of water source** *****inside own yard as reference compare to outside yard***	.196	1.217	1.120-1.322	<.001
Types of cooking fuel	**.074**	**1.077**	**0.869-1.335**	**0.497**

4.3.5. MODEL 4: Multivariate analysis of child demographic factors and household environmental factors associated with ARI in children aged under 5 years and MODEL 5: Multivariate analysis of all independent variables associated with ARI in children aged under 5 years in Bangladesh

Both in model 4 and model 5 Child's age had a highly significant association with ARI (p< 0.001).

Both of the models showed, Children, aged 6-12 months were 1.8 times more likely to develop ARI than those aged 48-59 months and children aged 0-5 months and 12-23 months aged were 1.6 times more likely to develop ARI than children aged 48-59 months while those aged 36-47 months were only 1.1 times more likely to develop ARI than those aged 48-59 months.
Both of model showed almost same results in case of child age.

In model 4, main source of drinking water had a positive significant effects on ARI (p=0.008).
Children belonged to household used unsafe water source as a source of drinking water were 1.3 times more likely to develop ARI than household used safe water source as a source of drinking water. In model 5, when main source of water adjusted with all predictors variables, it had no significant effect on ARI.

Same as location of the water source location had highly significant association with ARI (P=<.001) in model 4. Children belonged to household used water source outside yard were 1.2 times more likely to develop ARI than household used water source inside own yard as a source of drinking water. In model 5, when location of source water adjusted with all predictors variables, it had no significant effect on ARI.

In model 5, division had a highly significant association with ARI (p< 0.001). Children lived in Chittagong division and Khulna division were 2 times more likely to develop ARI than children lived in Sylhet division.

In model 5, Wealth index had a positive significant association with ARI(p=<.001). Children from poor household were 1.5 times more likely to develop ARI than rich household.

Total number of children in one household had a positive significant association with ARI(p=<.001). household had only one child were 1.2 times more likely to develop ARI than household with more than one child.

Education level of household head had a positive significant association with ARI(p=<.001). Children belonged to household where head had primary education were 1.1 times more likely to develop ARI than household where the head had secondary or higher education. Where head with no school education had no significant association with ARI development in child under 5 years.

Therefore, both in model 4 and model 5 showed, Child gender, breastfeeding status, nutritional status, Treatment of drinking water, types of cooking fuel, area, maternal educational level had no significant effects on ARI.

Table 11 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model 4 coefficients was highly significant with $\chi 2$= 147.966, d f=14, p=<0.001; Nagelkerke R square=1.4%; Hosmer & lemeshow test P=0.176; Classification accuracy=84.3%. Test for model 5 coefficients was highly significant with $\chi 2$= 484.958, d f=27, p=<0.001, Nagelkerke R square=4.5%, Hosmer & lemeshow test P=0.079, Classification accuracy=84.3%

Table 12: MODEL 4: Multivariate analysis of child demographic factors and household environmental factors associated with ARI in children aged under 5 years in Bangladesh. MODEL 5: Multivariate analysis of all independent variables associated with ARI in children aged under 5 years in Bangladesh

	Model 4				Model 5			
Variable	B	OR	95%CI	P	B	OR	95%CI	P
constant	-2.268	0.104		0.000	3.008	0.049		0.000
Child Age								
0-5 months	.487	1.627	1.387-1.909	<0.001	.523	1.68	1.435-1.986	<.001
6-11months	.613	1.846	1.583-2.153	<0.001	.623	1.86	1.596-2.180	<.001
12-23months	.519	1.681	1.476-1.914	<0.001	.514	1.67	1.466-1.907	<.001
24-35months	.429	1.536	1.346-1.752	<0.001	.421	1.52	1.333-1.740	<.001
36-47months	.182	1.199	1.048-1.373	0.008	.162	1.17	1.026-1.347	0.02
48-59months		1				1		
Child gender	-.045	. .956	.882-1.035	.267	.043	.96	.883-1.038	.296
Breast feeding status:	.301	1.351	.956-1.909	.088	0.261	1.29	.915-1.84	.143
Nutritional status:								
Height for age	.015	1.016	.944-1.092	.678	.023	1.02	.950-1.102	.550

Weight for age	-.076	.927	.844-1.018	.111	-.081	.922	.839-1.013	.091
Weight for height	.023	1.023	.910-1.150	.705	0.041	1.04	.926-1.173	.496
Main source of drinking water	.252	1.287	1.069-1.549	.008	0.070	1.07	.883-1.307	.481
Treat drinking water	.123	1.131	.923-1.387	.23	.169	1.184	.959-1.462	.116
Location of water source	.163	1.177	1.079-1.284	<.001	.024	1.024	.925-1.133	.646
Type of cooking fuel	-,135	0.873	.697-1.095	0.24	0.087	1.091	.849-1.402	0.46
Area					0.023	1.023	.907-1.155	.707
Division								
Barisal					.338	1.40	1.143-1.719	<.001
Chittagong					.737	2.09	1.760-2.483	<.001
Dhaka					-.188	0.82	0.690-.995	0.044
Khulna					.696	2.00	1.667-2.413	<.001
Rajshahi					.113	1.12	.908-1.382	.290
Rangpur					.413	1.51	1.247-1.831	<.001
Sylhet						1		
Wealth index								
Poor					.417	1.517	1.273-1.807	<.001
Middle class					0.154	1.166	1.005-1.353	0.043

Rich			1			
Total number of under 5 children in household		.185	1.20	1.099-1.322	<.001
Household head's education level					
None		-.011	0.989	.882-1.109	.848
Primary completed		0.117	1.124	1.004-1.258	.042
Secondary /higher			1		
Maternal education level		-.006	.994	.935-1.056	.842

4.3 Bivariate analysis of factors associated with diarrhea of children less than 5 years in Bangladesh.

Bivariate analysis was done by using binary logistic regression, where each independent variables were independently analyzed with dependent variable diarrhea**.** (child diarrhea was reported by mother /caretaker 2 week prior to survey)

4.3.1 Association between child demographic factors associated with diarrhea in children aged less than 5 years in Bangladesh.

Age of the child had a significant positive association with ARI (p =.000). The odds ratio (OR) suggests that children in household with 0-5 months were 1.3times, 6-11months were 4.5 times ,12-23 months 4.7 times ,24- 35months were 2.02 times and 36-47 months were 1.4 times more likely to develop diarrhea than children of 48-59 months

There was no statistically significant association between diarrhea and child sex, breast feeding status and nutritional status overall as shown in table (next page)

Table 13: Bivariate analysis of child demographic factors associated with diarrhea in children aged less than 5 years in Bangladesh

Variables	B	Unadjusted OR	95% CI
Sex			**P=.21**
• Male	0.088	1.091	0.950-1.255
• Female		1	
Age			**P=<.001**
• 0-5months	0.280	1.323	0.912-1.919
• 6-11months	1.498	4.473	3.372-5.933
• 12-23months	1.543	4.678	3.631-6.028
• 24-35months	0.705	2.025	1.531-2.678
• 36-47months	0.369	1.446	1.077-1.941
• 48-59months		1	
Breast feeding status			**P=.344**
• Ever breastfed	0.219	1.245	0.790-1.962
• Never breastfed		1	
Nutritional status			
Height for age z score			**P=.920**
• >-3	0.039	1.040	0.854-1.267
• -3 to -2.01	- 0.002	0.998	0.842-1.184
• ≥-2.00		1	
Weight for age z score			**P=.400**
• >-3	0.149	1.161	0.912-1.476
• -3 to -2.01	0.070	1.073	0.907-1.269
• ≥-2.00		1	
Weight for height z score			**P=.007**
• >-3	0.309	1.362	0.713-2.603
• -3 to -2.01	-0.107	0.898	0.516-1.563
• -2 to 2	-0.315	0.730	0.439-1.215
• >2		1	

4.3.2. Association between household demographic factors associated with diarrhea in children aged less than 5 years in Bangladesh.

Division had a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that children in Barisal were 1.6 times, Chittagong were 1.3 times, more likely to develop diarrhea than Sylhet division.

Wealth index had as a significant positive association with ARI (p =0.000). The odds ratio (OR) suggests that children in poor household had 1.5 times more likely to develop diarrhea than Rich household.

The odds ratio (OR) suggests that children in household head with primary completed education level had 1.2 times more likely to develop diarrhea than household head with secondary/higher completed. However, it is not significant in children with household head with no education with diarrhea.

The odds ratio (OR) suggests that children in maternal with primary completed education level had 1.2 times more likely to develop diarrhea than household head with secondary/higher completed. However, it is not significant in children with household head with no education with diarrhea.

The odds ratio (OR) suggests that household had only one child were 1.69 times more likely to develop ARI than more than one children.

There was no statistically significant association between diarrhea and number of children as shown in table below.

Table 14: Bivariate analysis of Household demographic factors associated with diarrhea in children aged less than 5 years in Bangladesh.

Variables	B	Unadjusted OR	95% CI
Area			**P=.179**
• Rural	-0.125	0.882	0.735-1.059
• Urban		1	
Division			**P=<.001**
• Barisal	0.503	1.654	1.228- 2.228
• Chittagong	0.297	1.346	1.029- 1.760
• Dhaka	-0.170	0.844	0.639-1.114
• Khulna	-0.117	0.890	0.65 -1.216
• Rajshahi	-0.024	0.976	0.702- 1.357
• Rangpur	0.027	1.028	0.757-1.394
• Sylhet		**1**	
Wealth index			**P=<.001**
• Poor	0.455	1.576	1.250- 1.986
• Middle class	0.066	1.068	0.853-1.337
• Rich		1	
Household head education level			**P=.059**
• None	0.136	1.146	0.966 -1.359
• Primary completed	0.222	1.248	1.039-1.500
• Secondary/higher completed		1	
Maternal education level			**P=.169**
• None	0.104	1.109	0.932-1.321
• Primary completed	0.190	1.209	1.028-1.422
• Secondary /higher completed		1	
Number of children under 5 in household			**P=.064**
• 1 child	0.148	1.159	0.992-1.355
• >1 child		1	

4.3.3 Association between household environmental factors associated with diarrhea in children aged less than 5 years in Bangladesh.

Main source of drinking water, treated drinking water and location of water source had a significant positive association with diarrhea (p=0.000). The odds ratio (OR) suggests that children in household with unsafe water drinking water supply were 1.98 times more likely to develop diarrhea than Safe source of drinking water, treated drinking water were 1.64 times less likely to develop diarrhea than untreated drinking water and water source locating outside the yard were 1.5times more likely to develop diarrhea than water source located inside yard.

Types of toilet facility had a significant association with diarrhea. The odds ration suggests that children in household with unimproved toilet facility were 1.49 times more likely to develop diarrhea than improved toilet facility. And there is no significant with shared toilet facility with diarrhea

There was no statistically significant association between diarrhea and treat drinking water as shown in table 9 (next page).

Table 15: Bivariate analysis of Household environmental factors associated with diarrhea in children aged less than 5 years in Bangladesh.

Variables	B	Unadjusted OR	95% CI
Main source of drinking water			**P=<.001**
• Unsafe source	0.687	1.987	1.546-2.553
• Safe source		1	
Treat drinking water			**P=<.001**
• No	- 0.472	0.623	0.478-0.814
• Yes		1	
Location of water source			**P=<.001**
• Outside yard	0.218	1.244	1.150-1.345
• Inside own yard		1	
Type of toilet facility P=<.001			
• Unimproved	0.401	1.493	1.294- 1.724
• Improved		1	
Sharing of toilet facility with other household			**P=.083**
• Shared	0.132	1.141	0.983-1.325
• Not shared		1	

4.3.4 Multi variate analysis: Multivariate analysis of factors associated with diarrhea in children aged less than 5 years

Binary logistic regression analysis was applied to form 5 models to predict the probability that a child less than 5 years would suffer from diarrhea. All the independent variables, which were applied to analysis the bivariate had selected as predictors to diarrhea of child under 5 years.

- In model 1, the child's factors were analyzed with the dependent variables (diarrhea)
- In model 2, the household socio demographic and economic factors, were analyzed with the dependent variables (diarrhea)
- In model 3, the household environmental factors, were analyzed with the dependent variables (diarrhea)
- In model 4. The child demographic factors and household environmental factors, were analyzed with the dependent variables (diarrhea)
- In model 5, All 3 groups including, child's factors household socio-demographic and economic factors, household environmental factors, were analyzed with the dependent variables (diarrhea)
-

4.3.4MODEL 1: Multivariate analysis of child demographic factors associated with diarrhea in children aged under 5 years in Bangladesh.

In model 1, the child demographic factors with diarrhea were analyzed by binary logistic regression.

In model 1, Child's age had a highly significant association with diarrhea ($p< 0.001$). Children, aged 6-11 months were 5.1 times, aged 12-23 months were 5 times more likely to develop ARI than children aged 48-59 months while those aged 0-5 aged months and 36-47 months were only were1.5 times more likely to develop diarrhea than those aged 48-59 months.

However, gender of the child, breastfeeding status and nutritional status had no significant effects on diarrhea.

Table 15 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was significant with $\chi 2$ ==287.085, df=10, p=<0.001; Nagelkerke R square=5.2%; Hosmer & lemeshow test P=0.542; Classification accuracy =96% (shown in model summary).

Table 16: MODEL 1: Multivariate analysis of child demographic factors associated with diarrhea in children aged under 5 years in Bangladesh.

	Model 1			
Variable	B	OR	95%CI	P
constant	**-3.228**	**.040**		**0.000**
Child Age				
0-5 months	.415	1.514	1.023-2.242	0.038
6-11months	1.643	5.173	3.835-6.978	<0.001
	1.620	5.056	3.850-6.638	<0.001
12-23months	.788	2.199	1.630-2.966	<0.001
24-35months	.437	1.548	1.130-2.120	0.006
36-47months		1		
48-59months				
Child gender	**-.067**	**.936**	**.809-1.082**	**.370**
Breast feeding status:	-.408	.665	.392-1.130	.132
Nutritional status:				
Height for age	-.026	.975	.855-1.111	.703
Weight for age	-.049	.952	.802-1.130	.573
Weight for height	-.144	.866	.708-1.059	.162

4.3.5 MODEL 2: **Multivariate analysis of household socio economic and demographic factors associated with diarrhea in children aged under 5 years in Bangladesh.**

In model 2, Area had a significant association with diarrhea (p= 0.032). Children who lived in rural area were 1.2 times more likely to develop diarrhea than who lived in urban area.

In model 2, division had a significant association with diarrhea (p< 0.001). Children lived in Barisal division were1.5 times more likely to develop diarrhea than children lived in Sylhet division

Wealth index had a positive significant association with diarrhea (p=<.001). Children from poor household were 1.6 times more likely to develop diarrhea than rich household.

Total number of children in one household had a positive significant association with diarrhea (p=0.02). household had only one child were 1.2 times more likely to develop diarrhea than household with more than one child.

Education level of household head and maternal educational level had no significant effects on diarrhea.

Table 16 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was highly significant with $\chi 2$ =75.587 , d f=12, p=<0.001; Nagelkerke R square=1.3%; Hosmer & lemeshow test P=0.873; Classification accuracy =96% (shown in model summary)

Table 17 MODEL 2: Multivariate analysis of household socio economic and demographic factors associated with diarrhea in children aged under 5 years in Bangladesh.

	Model 2			
Variable	B	OR	95%CI	P
constant	**-3.653**	**.026**		**0.000**
Area	.212	1.236	1.019-1.499	.032
Division				
Barisal	.409	1.505	1.110-2.040	.009
Chittagong	.235	1.265	.965-1.659	.089
Dhaka	-.194	.824	.622-1.092	.177
Khulna	-.169	.845	.614-1.162	.299
Rajshahi	-.082	.922	.659-1.288	.632
Rangpur	-.053	.948	.696-1.292	.736
Sylhet		***1***		
Wealth index				
Poor	.507	1.660	1.261-2.185	<.001
Middle class	.119	1.127	.882-1.439	.338
Rich		1		
Total number of under 5 children in household	.184	1.202	1.025-1.410	.023
Household head's education level	-.016	.984	.892-1.086	.751
Maternal education level	.046	1.047	.943-1.162	.390

4.3.6. MODEL 3: Multivariate analysis of household environmental factors associated with diarrhea in children aged under 5 years in Bangladesh.

In model 3, main source of household drinking water had a positive significant association with diarrhea (p=<0.001). Children belonged to household used unsafe water source as a source of drinking water were 1.8 times more likely to develop diarrhea than household used safe water source as a source of drinking water.

Location of the water source had highly significant association with diarrhea (P=<.001). Children belonged to household used water source outside yard were 1.4 times more likely to develop diarrhea than household used water source inside own yard as a source of drinking water.

Type of toilet facility had highly significant association with diarrhea (P=<.001). Children belonged to household with unimproved toilet facility were 1.4 times more likely to develop diarrhea than household with improved toilet facility. Shared sanitation facility also had significant association with diarrhea (p=0.016). Children belonged to household with shared sanitation facility were 1.2 times more likely to develop diarrhea than household with not shared sanitation facility.

Treatment of water had no significant effects on diarrhea.

Table 18 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model coefficients was highly significant with $\chi 2$ = square192.753, d f=5, p=<0.001, Nagelkerke R square=1.7%,Hosmer & lemeshow test P=0.877, Classification accuracy =96% (shown in model summary)

Table 18 **MODEL 3**: **Multivariate analysis of household socio economic and** demographic factors associated with diarrhea in children aged under 5 years in Bangladesh.

	Model 3			
Variable	B	OR	95%CI	P
Constant	**-3.513**	**.030**		**0.000**
Main source of drinking water	.610	1.841	1.358 2.496	<.001
Treat drinking water	**.204**	**1.227**	**.880 1.710**	**.229**
Location of water source	.333	1.395	1.194 1.630	<.001
Types of toilet facility	**.366**	**1.441**	**1.229 1.691**	**<.001**
Shared sanitation	.188	1.207	1.036 1.406	.016

4.3.7MODEL 4: Multivariate analysis of child demographic factors and household environmental factors associated with diarrhea in children aged under 5 years and MODEL 5: Multivariate analysis of all independent variables associated with diarrhea in children aged under 5 years in Bangladesh

Both in model 4 and model 5 Child's age had a highly significant association with Diarrhea (p< 0.001).
Both of the models showed, Children, aged 6-11 months were 4.8 times and 12-23 months were 5.1times more likely to develop diarrhea than those aged 48-59 months and children aged 0-5 months were 1.5 times more likely to develop diarrhea than children aged 48-59 months Both of model showed almost same results in case of child age.

In model 4, and in model 5 main source of drinking water had a positive significant effects on diarrhea (<p=0.001). Children belonged to household used unsafe water source as a source of drinking water were 1.9 times more likely to develop diarrhea than household used safe water source as a source of drinking water. In model 5, it showed little difference of 1.78 times more likely to develop diarrhea than household used safe water source as a source of drinking water

Same as location of the water source location had highly significant association with diarrhea (P=<.001) in model 4. Children belonged to household used water source outside yard were 1.4 times more likely to develop ARI than household used water source inside own yard as a source of drinking water. In model 5, it showed significantly association with diarrhea (p=0.015) Children belonged to household used water source outside yard were 1.2 times more likely to develop diarrhea than household used water source inside own yard as a source of drinking water.
Both in model 4 and model 5, type of toilet facility had significant association with diarrhea (p=<.001). Children who belonged to household with unimproved toilet facility were 1.5 times more and were 1.3 times more likely to develop diarrhea in model 4 and in model 5 respectively.
In both model showed, shared sanitation had significant association with diarrhea (p=) children who belonged to household with shared sanitation were 1.2 times more likely develop diarrhea in both models,
Therefore, both in model 4 and model 5 showed, Child gender, breastfeeding status, nutritional status, Treatment of drinking water, area, division, wealth index, total number of children, maternal educational level, household head education level had no significant effects on diarrhea.

Table 19 shows the logistic regression coefficients, adjusted odds ratios with their 95% CIs and the Wald test p values of predictor variables. Test for model 4 coefficients was highly significant with $\chi2$= :357.402, d f=15, p=<0.001, Nagelkerke R square=6.9%Hosmer & lemeshow test P=0.848, Classification accuracy=95.9% Test for model 5 coefficients was highly significant with $\chi2$=393.560, d f=27, p=<0.001, Nagelkerke R square=7.6%, Hosmer & lemeshow test P=0.821, Classification accuracy=95%.

Table 19 MODEL 4: Multivariate analysis of child demographic factors and household environmental factors associated with diarrhea in children aged under 5 years and MODEL 5: Multivariate analysis of all independent variables associated with diarrhea in children aged under 5 years in Bangladesh

	Model 4				**Model 5**			
Variable	B	OR	95%CI	P	B	OR	95%CI	
constant	**-3.622**	**.027**		**0.000**	**-3.688**	**.025**		**0.000**
Child Age								
0-5 months	.432	1.540	1.032-2.298	0.034	.445	1.56	1.045-2.331	.030
6-11months	1.573	4.822	3.535-6.579	<0.001	1.576	4.83	3.542-6.607	<.001
12-23months	1.648	5.197	3.928-6.875	<0.001	1.647	5.19	3.919-6.874	<.001
24-35months	.806	2.239	1.646-3.047	<0.001	.801	2.22	1.636-3.032	<.001
36-47months	.379	1.460	1.053-2.025	0.023	.366	1.44	1.039-2.000	0.029
48-59months		1				1		
Child gender	-.092	.912	.784-1.061	.232	-.095	.90	.781-1.058	.217
Breast feeding status:	-.417	.659	.380-1.142	.137	-.388	.678	.390-1.179	.169
Nutritional status:								
Height for age	.038	1.038	.905-1.192	.591	.047	1.04	.913-1.204	.505
Weight for age	-.069	.933	.782-1.115	.447	-.063	.93	.786-1.122	.490
Weight for height	-.113	.894	.724-1.103	.294	-.105	.90	.729-1.112	.328

Main source of drinking water	.645	1.906	1.371-2.650	<.001	.578	1.782	1.273-2.495	.001
Treat drinking water	.081	1.084	.758-1.550	.658	.134	1.143	.792-1.650	.475
Location of water source	.360	1.433	1.218-1.686	<.001	.230	1.258	1.045-1.514	.015
Types of toilet facility	.401	1.493	1.263-1.765	<.001	.301	1.351	1.129-1.617	.001
Shared sanitation	.164	1.178	1.004-1.382	.044	.188	1.206	1.022-1.424	.027
Area					.160	1.174	.947-1.454	0.143
Division								
Barisal					.310	1.364	.981-1.896	.065
Chittagong					.174	1.190	.886-1.596	.247
Dhaka					-.245	.783	.576-1.064	.118
Khulna					-.252	.777	.553-1.092	.146
Rajshahi					-.028	.973	.678-1.397	.881
Rangpur					.087	1.091	.770-1.544	.625
Sylhet						1		
Wealth index								
Poor					.261	1.29	.929-1.814	0.127
Middle class					.035	1.03	.781-1.372	0.808
Rich								

			1		
Total number of under 5 children in household		-.144	.866	.728 - 1.030	.103
Household head's education level		.000	.999	.899-1.111	.990
Maternal education level		-.004	.996	.888-1.117	.944

CHAPTER V

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

This study examined the household environmental factors associated with diarrhea and ARI among children aged less than 5 years in Bangladesh using data from the MICS conducted from December, 2012 to April, 2013

The results of this study will be discussed under the following parts

5.1.1. Prevalence of diarrhea and ARI in children under 5 years' old in Bangladesh.

5.1.2. Association between child's demographic factors and diarrhea and ARI in children under 5 years old in Bangladesh.

5.1.3. Association between household socio-demographic and economic factors and diarrhea and ARI in children under 5 years old in Bangladesh.

5.1.4. Association between household environmental factors and diarrhea and ARI in children under 5 years old in Bangladesh.

5.1.1 Prevalence of diarrhea and ARI in children under 5 years' old in Bangladesh.

The prevalence of ARI was 15.6% (3260 out of 20903 children) while that of diarrhea was 4 % (829out of 20903 children) respectively, in the two weeks prior to the survey date.

The 2007 Bangladesh Demographic and Health Survey (BDHS), reported diarrhea prevalence of 10% among children < 5 years of age from using a 2-week recall period, the prevalence of diarrhea was 5% in 2011 BDHS, 6 % in 2014 BDHS compared with 4% among our study participants.

In this study ARI prevalence was higher among children (15.6%) compared with the national estimates (5%) reported in BDHS 2007, 6% reported in BDHS 2011 and 5 % reported in BDHS 2014 in the period of 2 weeks preceding the surveys.

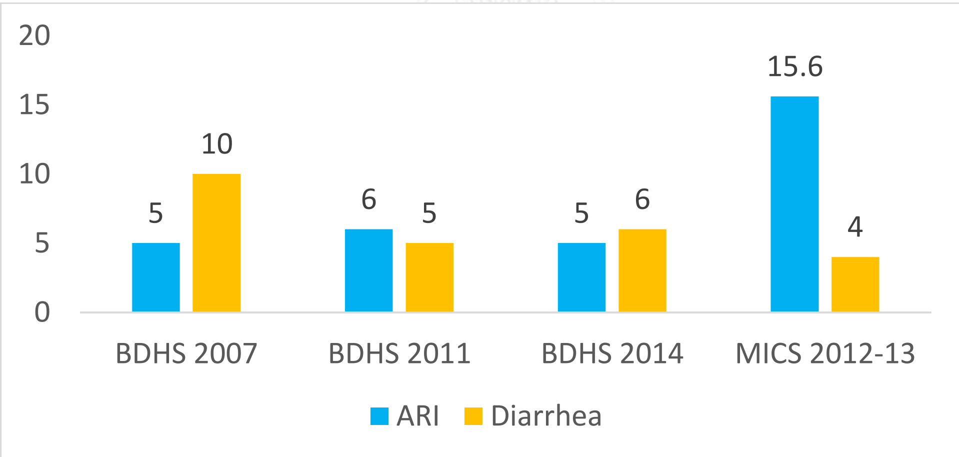

Figure 4 PREVELENCE OF ARI AND DIARRHEA IN BANGLADESH

Another study in Guatemala showed the number (prevalence) of cases of severe pneumonia and severe diarrhea were 364 (11.6%) and 481 (15.3%), respectively. (Bruce et al., 2014) This could mean that the prevalence of Diarrhea in Bangladesh is lower than in many developing countries.

However, BDHS used a different ARI definition. (Halder et al., 2017) and the prevalence of diarrhea varies seasonally, the BDHS survey results pertain only to the period from June to October, when the fieldwork took place (NIPORT, 2014) With the MICS survey having been conducted from December to April, there is therefore a possibility that seasonal variations resulted into increased number of reported cases of ARI but not diarrhea during the survey. The data however is very important in understanding the pattern of reported cases of ARI and diarrhea over the year and hence helpful in interpreting the prevalence of diarrhea and ARI observed in MICS survey.

5.1.2. Association between child's demographic factors and diarrhea and ARI in children under 5 years old in Bangladesh.

Male children 51.3% and 48.7% female of children accounted for surveyed. There was no significant association was found between child's gender and both diarrhea and ARI before and after adjusting with confounders. This finding contradict with studies which showed in community-based studies had sex-specific data for pneumonia and diarrhea incidence, which was higher in boys than in girls (Walker et al., 2013) and 28 unpublished studies (Nair ,2010)

This study found a strong association between child's age and both diarrhea and ARI both before after controlling for confounders in bivariate and multivariate analysis.

This study found the higher risk of diarrhea among children aged 6-23 months (with the highest risk being among children aged 6-12 months). The highest risk of ARI was found in children, same as aged 6-23 months in bi variate analysis. Age 0-23 months became more associated with ARI when it was adjusted with both household demographic, household environmental factors. Whereas children aged 24-59 months were less associated with ARI.

Studies in Ghana, with children between the ages of 24 and 59 months having the lowest risk of diarrhea and cough and at 12–23 months were pick periods (Amugsi et al., 2015). In multi variate analysis, aged 6-23 months are more porn to Diarrhea in this study. Our results are similar to the findings of previous studies in sub-Saharan Africa.(Mihrete, Alemie, & Teferra, 2014) A study in Eritrea found that the risk of diarrhea infection peaks at age 6–11 months(Woldemicael, 2001) In Ethiopia, the morbidity peak occurred among children 6–11 and 12–23 months, respectively(Habtemariam) .

High risk of morbidity in the 12–23 months age could be due to loss of innate immunity and/or exposure to different types of infections from eating contaminated food prepared with unclean water and in unhealthy environment as reported in other studies(Elizabeth & Raj, 2012).

On the other hand, low risk of morbidity among older children could be due to the immunity the children build over time, which enables their bodies to fight off infectious agents from the environment. A possible explanation for this is that children aged less than six months have less contact with the environment and are taken care of cautiously.

They also benefit from the protective effect of breast milk (if breastfeeding) From 6 months, children are introduced to a variety of foods besides becoming increasingly mobile thereby increasing their chances of contamination and infection (especially for diarrhea), bearing in mind that their immune system is still under developed.

Breast feeding status showed not significant in case of ARI and Diarrhea in both bivariate and multivariate analysis. The protective effect of breastfeeding on child morbidity has been widely documented in both high-income(Arifeen et al., 2001; Duijts, Jaddoe, Hofman, & Moll, 2010) lower middle-income countries(Arifeen et al., 2001)

However, it is important to note that although breastfeeding was not significant in the initial model for diarrhea and the final model for cough, it is appropriate to conclude that breastfeeding has a protective effect on child morbidity, but that the effect is dependent to some extent on what variables are adjusted for in the analysis and absence of data for the different level of measurement of breastfeeding status.

Malnutrition is a known risk factor for both diarrhea and ARI for children.(Kinyoki et al., 2017b) This study however failed to show an association between any of the three indicators of nutrition (weight for age, weight for height and height for age) with diarrhea and ARI by bivariate analysis and multivariate analysis . These findings were unexpected given that 15.3% of children were severely stunted and 23.8% were moderately stunted, 22.4% underweight and 7.6% wasted. This study suggests that in Bangladesh diarrhea and ARI in children are associated with other factors other than the nutritional status of a child. More studies should be done to clarify this unanticipated observation.

5.2.3Association between household socio-demographic and economic factors and diarrhea and ARI in children under 5 in Bangladesh.

Household socio-demographic and economic factors can bear significant impacts on diarrhea and ARI morbidity in children.

About 84.1 % of children that participated in the study were from households located in rural area. But in this study did not find any association between area and ARI both in bivariate and multivariate analysis. Similarly, there were no association found between area and diarrhea in bivariate analysis. In multivariate analysis, Area had a significant association with diarrhea Children who lived in rural area were more likely to develop diarrhea than who lived in urban area (model 2). But Area became again insignificant when it combines with household environmental factors and child demographic factors as control. (model 5). Similarly ,rural–urban setting was not found to have a significant effect on the prevalence of either diarrhea or ARI in Pakistan ,Nepal and Bangladesh.(Hasan & Richardson, 2017).But opposite findings were found in both in Uganda and Eritrea that rural areas being more susceptible to occurrence of both ARI and Diarrhea (Bbaale, 2011) (Woldemicael, 2001).

Division showed highly significant association with ARI both in bivariate and multivariate analysis. Chittagong and Khulna divisions are more likely develop ARI when adjusted with all predictors (model 5).Similar findings have been found for Chittagong division in previous study in Bangladesh (Kamal, Hasan, & Davey, 2015) Since Khulna is the largest and Chittagong is the second largest port city and industrial area of Bangladesh which may lead to increase risks of exposure of outdoor air pollution to the children specially in dry season.(SATTAR & UDDIN, 2005). this in turn may be expected to put children in this region at an elevated risk of respiratory infection. In case of diarrhea division showed significant association in bi variate analysis. When it was adjusted with other predictors, it lost the association with diarrhea (model 5).

Wealth index had significant association with both ARI and diarrhea before and after adjusting for other factors. In this study, children from poor household were more likely to have ARI and diarrhea compare to rich household. This finding is consistent with several studies which have found similar findings in India, Uganda (Avachat, Phalke, Phalke, Aarif, & Kalakoti, 2011; Bbaale, 2011)and in low income and lower middle income countries (Sonego et al., 2015). Generally, children living in poor households have higher diarrhea rates than their wealthier counterparts, probably due to inadequate access to sanitary facilities, unsanitary environments in the home and poor child hygiene. Low socioeconomic status is likely to increase the morbidity risk through several factors, such as, among others, poor nutritional status, poor housing conditions, and reduced access to healthcare and preventive programs

Education level of household head had significant association with both ARI and Diarrhea in independently in bivariate analysis. Children had more ARI where household head who had primary education were more none or higher education in multivariate analysis (model 2, model 5). Similar finding has been reported in Uganda (Bbaale, 2011)This result is counter-intuitive and hence surprising. It might be the case that primary education is too low to yield favorable health outcomes. These findings contradict those found in Turkey where father's education was revealed as particularly important.(Etiler, Velipasaoglu, & Aktekin, 2002) However, in multivariate analysis, when household head education level adjusted with all predictors, it showed no association with diarrhea in final model (model 5).

Majority of mother (45%) of the children had secondary or high education level and 25.1 % had no education which showed no significant association with both ARI and Diarrhea either of the analysis. This was also reported by studies in Eritrea , Egypt and Ethiopia (Tarekegn, 2012) This findings were contradict with the results of several studies done in lower income countries and lower middle income countries (Sonego et al., 2015).

The total number of children in household is an important demographic factor which influence the prevalence of childhood morbidity. This study found significant association between number of children under 5 years in the household and ARI by bivariate analysis, where risk of ARI raise with the only one child in household. This significance was maintained for ARI in multi variate analysis. This finding contradict with another study done in Eritrea. (Woldemicael, 2001). The possible explanation of this outcome is, household with one child were more affected than more than one child during this periodic episode of ARI.

But number of children was not associated with diarrhea in both bi variate and multivariate analysis after adjusting all socio demographic and environmental factors (model 5). This finding can be explained by due unsafe environmental can affect each child in the household weather one or more children present in household.

5.1.4. Association between household environmental factors and diarrhea and ARI in children under 5 years old in Bangladesh.

Main source and of drinking water were associated with both diarrhea and ARI in children in bivariate analysis. Children living those household use unsafe source for drinking water had risk to develop both ARI and diarrhea. ARI showed association when analyzed with child demographic factors as control but it lost association when analysis with all of the predictors (model 5). A similar scenario was observed in Uganda. (Bbaale, 2011) Investigating 171 Demographic and Health Surveys (DHS) in 70 low-income and middle-income countries over the period 1986–2007, researchers also concluded that access to improved sanitation and water was associated with lower risk of childhood diarrhea.(Fink, Günther, & Hill, 2011).This is contrary to the findings in a study conducted in Ethiopia. (Mekasha, 2003)

Whereas 95.3% of households have access to safe drinking water, 95% of household don't treat water to make it safe for drinking. In case of ARI and diarrhea treatment of drinking water showed no association in children. This finding has been contrary with water quality interventions, which were effective in reducing diarrhea even in the absence of improved water supplies and sanitation. (Clasen, 2007, Maponga, 2013) Previous study in Bangladesh showed the importance of water treatment practices in reducing childhood morbidity in the country. However, they also suggested that for water treatment practice to be more effective the water itself should be sourced from the pipe.(Kamal et al., 2015) This study showed maximum household were using safe source that includes pipe water.

Location of water source of the household were significantly associated with ARI in both bivariate and multi variate analysis when adjusted with child demographic factors (model 4). Our result relevels that children who lived in the household collect water from outside of their yard tends to develop more ARI compare to those collect yard from their own yard. But it became insignificant after adjusted with all the control variable in final model (model 5). Location of water source of the household were significantly associated with diarrhea in both bivariate and multi variate analysis. Similar findings had been reported by studies in India, Ethiopia (Jalan, 2003) (Mitike, 2001).

These observations in Bangladesh could mean that water from sources, considered unimproved, outside yard can easily become contaminated (fecal contamination) and predispose children to infections.

Type of toilet facility and shared sanitation both were significantly associated with diarrhea in children under 5 years in both bi variate and multivariate analysis. Children living in this household environment with unimproved and shared sanitation facility were more prone develop diarrhea. This had been reported in many studies in Zimbabwe, Ethiopia, Ghana (Schilmann, 2015) (Amugsi, 2015).

Type of cooking fuel was significantly associated with ARI in children by bivariate analysis; with clean fuels (electricity, LPG and biogas) being linked to less ARI in children. After adjusting for other factors (model 3, model 4 and model 5) this significance was lost among children aged less than five years. We expected it to have to have a strong effect on ARI, but the reverse became true. Similar findings had been reported by a study in Uganda (Bbaale, 2011) This finding contradicts with a case control study conducted in Nepal which found an association between ARI and solid fuel use among children aged 2-35 months. (Bates, 2013), meta-analysis including Africa China, Latin America (Dherani, 2008) and intervental study in Mexico. (Schilmann, 2015) According to MICS suryey 92.7% household were using pollute cooking fuel, so further investigation is needed to execute the finding.

Conclusion and Recommendations:

We can conclude from this MICS survey that children age is common risk factor for both Acute Respiratory Infection (0-35 months) and diarrhea (6-35 months). Household environmental factors showed no risk in case of childhood ARI, only household demographic & socio –economic factors were more risk in developing ARI of under 5 children in Bangladesh. In the contrast, household environmental factors were more alarming factors towards diarrhea among under 5 children in Bangladesh. These results indicate that both MDG & SDG of good health and well-being needs to be tackled by incorporating quality health education along with the goals of clean water and sanitation for all and no poverty.

Strength of the study:

- Findings from cross-sectional studies are important, as they provide potential directions for further investigation in poorly understood areas and problem identification.
- This study provides a picture of factors associated with diarrhea and ARI at national level and can therefore be useful for policy making at these level interventions related specifically to housing and environmental conditions in Bangladesh.

Limitations of this study:

1. MICS are cross-sectional surveys which collect information regarding the disease episodes for a single point of time. Such studies can yield information on association but not impact.
2. The seasonal variations in the prevalence of the disease episodes are not addressed in the data.
3. Moreover, the disease episodes are determined on the basis of self-reporting of mothers and not followed by any clinical examination.
4. Since in survey both ARI and Diarrhea reported by the caretaker/mother, there is potential for recall bias. To reduce the reporting bias due to memory lapse, a short recall period (2 weeks) is considered while collecting morbidity related information.
5. Children who were not de-jure resident at the time of the survey were excluded from the analysis.
6. The exclusion and absence of some important variables to measure the outcome such as immunization, passive smoking, and presence of co-morbid etc. may lead a bias to the outcomes; however, the amount of bias is likely to be small.

Recommendation

Based on the findings of this study, the following recommendations can be made:

- Because children those aged 6-35 months have higher risk of getting diarrhea and aged 0-53 months ARI, they should receive special attention in prevention efforts and increase more frequent health checkup and follow up.
- Interventions which are known to prevent ARI in children should be emphasized more in Chittagong, Khulna, Barisal, and Rangpur division of Bangladesh.
- Children in the poor wealth index had the highest risk of ARI. Policy makers should support this target group in health services and take initiative to reduce the poverty level.
- Further investigation should be done regarding the association of smoke of pollute fuel with ARI since maximum household are using pollute fuels for cooking.
- An effective basic knowledge based on health education in school curriculum at primary level has a good chance of making an impact.
- Because children those aged 6-35 months have higher risk of getting diarrhea and aged 0-53 months ARI, they should receive special attention in prevention efforts and increase more frequent health checkup and follow up.
- Policy makers should take initiative to make safe and sustainable household environment by facilitating safe water supply, improve sanitation to diminish these communicable infections
- All the house members should be educated the about the maintenances of household environment and water quality and hygiene practice.
- Well-developed motivational programs incorporating mass media, health professionals, community health workers, community leaders, government and non-government organizations may help improve

population awareness of the causes and consequences of infectious diseases

- Alternative ways to develop knowledge of healthy practices among the mass population could be delivered through mass media.
- Further research, in the form of longitudinal studies, is needed to understand the complete dynamics of diarrhea and ARI morbidity and associated factors.

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APPENDIX

Bangladesh MICS Questionnaires

MICS MICS5, Bangladesh 2012-13

HOUSEHOLD QUESTIONNAIRE

HOUSEHOLD INFORMATION PANEL HH			
HH1. Cluster number: .... ___ ___ ___ ___		HH2. Household number: .... ___ ___	
HH3. Interviewer name and number:		HH4. Supervisor name and number:	
Name ________________________ ....___ ___		Name_____________________ .... ___ ___	
HH5. Day / Month / Year of interview: ___ ___ /___ ___ / ___ ___ ___ ___		HH7. Division: Barisal ....10 Chittagong ....20 Dhaka ....30 Khulna ....40 Rajshahi...50 Rangpur ....55 Sylhet 60	
HH6. Area: Urban .... 1 Rural 2			
HH7A. District name and code Name ________________________ ___ ___			
HH7B. Is the household selected for water testing?	Yes ....1 No 2	HH7C. Is the household selected for additional water testing?	Yes ....1 No 2

We are from Bangladesh Bureau of Statistics. We are collecting information on family health and education I would like to talk to you about these subjects. The interview will take about 45 minutes. All the information we obtain will remain strictly confidential and your answers will never be shared with anyone other than our project team.

MAY I START NOW?

Yes, permission is given ⇨ *Go to HH18 to record the time and then begin the interview.*

No, permission is not given ⇨*Circle 04 in HH9. Discuss this result with your supervisor.*

After all questionnaires for the household have been completed, fill in the following information:	
HH8. Name of head of household:	______________________________
HH9. Result of household interview: Completed --- 01 No household member or no competent respondent at home at time of visit ----------------- 02 Entire household absent for extended period of time -- 03 Refused -- ----------- 04 Dwelling vacant / Address not a dwelling - ----------- 05 Dwelling destroyed -------------- ----------------------- 06 Dwelling not found ---------------------------- --------- 07 Other (specify) ---------------------------------- --------- 96	HH10. Respondent to household questionnaire: Name: ....______________________ Line Number: .... HH11. Total number of household members: -- -----
HH12. Number of women age 15-49 years: ------------------------------ -------------	HH13. Number of woman's questionnaires completed: ....

WATER AND SANITATION		**WS**
WS1. What is the main source of drinking water for members of your household?	Piped water Piped into dwelling ....11 Piped into compound, yard or plot ....12 Piped to neighbour ....13 Public tap / standpipe ....14 Tube Well, Borehole ....21 Dug well Protected well ....31 Unprotected well ....32 Water from spring Protected spring ....41 Unprotected spring ....42 Rainwater collection ....51 Tanker-truck ....61 Cart with small tank / drum ....71 Surface water (river, stream, dam, lake,	11 ⇨ WS6 12 ⇨ WS6 13 ⇨ WS6 14 ⇨ WS3 21 ⇨ WS3 31 ⇨ WS3 32 ⇨ WS3 41 ⇨ WS3 42 ⇨ WS3 51 ⇨ WS3 61 ⇨ WS3 71 ⇨ WS3 81 ⇨ WS3 96 ⇨ WS3

	pond, canal, irrigation channel) ....81 Bottled water ....91 Other (*specify*) 96	
WS3. Where is that water source located?	In own dwelling ....1 In own yard / plot ....2 Elsewhere 3	1 ⇨ WS6 2⇨ WS6

WATER AND SANITATION : continued WS		
WS6. Do you do anything to the water to make it safer to drink?	Yes ....1 No ....2 DK....................8	2 ⇨ WS8 8 ⇨ WS8
WS8. What kind of toilet facility do members of your household usually use? *if "flush" or "pour flush", probe:* Where does it flush to? *If necessary, ask permission to observe the facility.*	Flush / Pour flush Flush to piped sewer system ....11 Flush to septic tank ....12 Flush to pit (latrine) ....13 Flush to somewhere else ....14 Flush to unknown place / Not sure / DK where ....15 Pit latrine Ventilated Improved Pit latrine (VIP) ....21 Pit latrine with slab ....22 Pit latrine without slab / Open pit ....23 Composting toilet ....31 Bucket ....41 Hanging toilet, Hanging latrine ....51 No facility, Bush, Field ....95 Other (*specify*) 96	95 ⇨ Next Module
WS9. Do you share this facility with others who are not members of your household?	Yes ....1 No 2	2 ⇨ Next Module

HOUSEHOLD CHARACTERISTICS : continued		HC
HC6. What type of fuel does your household mainly use for cooking?	Electricity ....01 Liquefied Petroleum Gas (LPG) ....02 Natural gas ....03 Biogas ....04 Kerosene ....05 Coal / Lignite..06 Charcoal ....07 Wood ....08 Straw / Shrubs / Grass ....09 Animal dung ....10 Agricultural crop residue ....11 No food cooked in household ....95 Other (*specify*) 96	01 ⇨ HC8 02 ⇨ HC8 03 ⇨ HC8 04 ⇨ HC8 05 ⇨ HC8 95 ⇨ HC8

QUESTIONNAIRE FOR CHILDREN UNDER FIVE
MICS5, Bangladesh 2012-13

UNDER-FIVE CHILD INFORMATION PANEL UF	
This questionnaire is to be administered to all mothers or caretakers (see Household Listing Form, column HL9) who care for a child that lives with them and is under the age of 5 years (see Household Listing Form, column HL6). A separate questionnaire should be used for each eligible child.	
UF1. Cluster number: ___ ___ ___ ___	UF2. Household number: ___ ___
UF3. Child's name: Name___________________	UF4. Child's line number: ___ ___
UF5. Mother's / Caretaker's name: Name___________________	UF6. Mother's / Caretaker's line number: ___ ___
UF7. Interviewer name and number: Name___________________ ___ ___	UF8. Day / Month / Year of interview: ___ ___ / ___ ___ / ___ ___ ___ ___

Repeat greeting if not already read to this respondent:

We are from Bangladesh Bureau of Statistics. We are working on a project concerned with family health and education. I would like to talk to you about (*name*)'s health and well-being. The interview will take about 30 minutes. All the information we obtain will remain strictly confidential and your answers will never be shared with anyone other than our project team.

May I start now?

If greeting at the beginning of the household questionnaire has already been read to this person, then read the following:

Now I would like to talk to you more about (*name*)'s health and other topics. This interview will take about 30 minutes. Again, all the information we obtain will remain strictly confidential and your answers will never be shared with anyone other than our project team

BREASTFEEDING		
BF1. Has (*name*) ever been breastfed?	Yes..1 No ....2 DK 8	 2⇨BF3 8⇨BF3

AGE	
AG1. Now I would like to ask you some questions about the health of (*name*). In what month and year was (*name*) born? Probe: What is his / her birthday? *If the mother/caretaker knows the exact birth date, also enter the day; otherwise, circle 98 for day* *Month and year must be recorded.*	Date of birth Day ....__ __ DK day ....98 Month ....__ __ Year .... __ __ __ __

CARE OF ILLNESS		CA
CA1. In the last two weeks, has (*name*) had diarrhoea?	Yes..1 No ....2 DK 8	 2⇨CA7 8⇨CA7

CA7. At any time in the last two weeks, has (*name*) had an illness with a cough?	Yes..1 No ....2 DK 8	 2⇨CA14 8⇨CA14
CA8. When (*name*) had an illness with a cough, did he/she breathe faster than usual with short, rapid breaths or have difficulty breathing?	Yes..1 No ....2 DK 8	 2⇨CA14 8⇨CA14

ANTHROPOMETRY		AN
After questionnaires for all children are complete, the measurer weights and measures each child. Record weight and length/height below, taking care to record the measurements on the correct questionnaire for each child. Check the child's name and line number on the household listing before recording measurements.		
AN1. *Measurer's name and number:*	Name_______________ ___ ___	
AN2. *Result of height / length and weight measurement*	Either or both measured ....1 Child not present ....2 Child or mother/caretaker refused ....3 Other (specify) ___________________________ 6	 2⇨AN6 3⇨AN6 6⇨AN6
AN3. *Child's weight*	Kilograms (kg) .... Weight not measured 99.9	
AN4. *Child's length or height* Check age of child in AG2: ? Child under 2 years old. ⇨ Measure length (lying down). ? Child age 2 or more years. ⇨ Measure height (standing up).	Length (cm) Lying down .... 1 __ __ __ . __ Height (cm) Standing up .... 2 __ __ __ . __ Length / Height not measured.................. 9999.9	

:

ETHICAL APPROVAL

AF 02-12

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University
Jamjuree 1 Building, 2nd Floor, Phyathai Rd., Patumwan district, Bangkok 10330, Thailand,
Tel/Fax: 0-2218-3202 E-mail: eccu@chula.ac.th

COA No. 124/2017

Certificate of Approval

Study Title No. 079.1/60 : HOUSEHOLD ENVIRONMENTAL FACTORS TOWARDS ACUTE RESPIRATORY INFECTON AND DIARRHEA AMONG CHILDREN UNDER 5 YEARS OLD IN BANGLADESH: A SECONDARY ANALYSIS OF BANGLADESH MULTIPLE INDICATOR CLUSTER SURVER 2012-2013

Principal Investigator : SHAKINA SULTANA

Place of Proposed Study/Institution : College of Public Health Sciences, Chulalongkorn University

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University, Thailand, has approved constituted in accordance with the International Conference on Harmonization – Good Clinical Practice (ICH-GCP).

Signature: Prida Tasanapradit
(Associate Professor Prida Tasanapradit, M.D.)
Chairman

Signature: Nuntaree Chaichanawongsaroj
(Assistant Professor Nuntaree Chaichanawongsaroj, Ph.D.)
Secretary

Date of Approval : 12 June 2017

Approval Expire date : 11 June 2018

The approval documents including

1) Research proposal
2) Researcher

Protocol No. 079.1/60
Date of Approval 12 JUN 2017
Approval Expire Date 11 JUN 2018

The approved investigator must comply with the following conditions:

1. *The research/project activities must end on the approval expired date of the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University (RECCU). In case the research/project is unable to complete within that date, the project extension can be applied one month prior to the RECCU approval expired date.*
2. *Strictly conduct the research/project activities as written in the proposal.*
3. *Using only the documents that bearing the RECCU's seal of approval with the subjects/volunteers (including subject information sheet, consent form, invitation letter for project/research participation (if available).*
4. *Report to the RECCU for any serious adverse events within 5 working days*
5. *Report to the RECCU for any change of the research/project activities prior to conduct the activities.*
6. *Final report (AF 03-12) and abstract is required for a one year (or less) research/project and report within 30 days after the completion of the research/project. For thesis, abstract is required and report within 30 days after the completion of the research/project.*
7. *Annual progress report is needed for a two- year (or more) research/project and submit the progress report before the expire date of certificate. After the completion of the research/project processes as No. 6.*

VITA

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