Assessing Socio-economic and Environmental Factors contributing to the Incidence and Prevalence of Diarrheal Diseases
In Under-five Children in Afghanistan
A literature Review

A thesis submitted for the partial fulfilment of the requirement for the degree of Master's in Public Health at Royal Tropical Institute, Amsterdam, Netherlands

By

Dr. Jawaid Waak

Afghanistan

55th International Course in Health Development / Master of Public Health/ Policy and Management in Health

17 September 2018 – 7 September 2019

KIT (Royal Tropical Institute)/ Vrije Universiteit Amsterdam

Amsterdam, The Netherlands

Declaration

Where other people's work has been used (either from a printed source, internet or any other source) this has been carefully acknowledged and referenced in accordance with departmental requirements.

The thesis "Assessing socio-economic and environmental factors contributing to the incidence and prevalence of acute diarrheal diseases in under-five children in Afghanistan- a literature review" is my own work.

Signature

55th International Course in Health Development (ICHD)

17 September 2018 – 7 September 2019

KIT (Royal Tropical Institute)/ Vrije Universiteit Amsterdam

Amsterdam, The Netherlands

September 2019

Organized by

KIT (Royal Tropical Institute), Development Policy and Practice

Amsterdam, The Netherlands

In co-operation with

Vrije Universiteit Amsterdam/ Free University of Amsterdam (VU)

Amsterdam, The Netherlands

Dedication

To my beloved parents Dr. Qiam-uddin Waak and N. Waak

Respected uncles, my wife, brothers, sisters

&

All my readers

Table of Contents

List of Tables

List of Figures

List of Annexes

List of Abbreviations

Abbreviations	Extensions	Abbreviations	Extensions
AIP	Afghan Immunization Plan	**M&E**	Monitoring & Evaluation
ANC	Ante-Natal Care	**MNH**	Maternal and Newborn Health
ANDS	Afghanistan National Development Strategy	**MOPH**	Ministry of Public Health
AOR	Adjusted Odds Ratio	**MRRD**	Ministry of Rural Rehabilitation and Development
BHC	Basic Health Center	**MUAC**	Mid Upper Arm Circumference
BPHS	Basic Package of Health Services	**NAR**	Net school attendance ratio
CHC	Comprehensive Health Center	**NEPA**	National Environment Protection Agency of Afghanistan
CHW	Community Health Worker	**NGOs**	Non Governmental Organizations
CI	Confidence Interval	**NHPS**	National Hygiene Promotion Strategy
CSO	Central Statistics Organization	**OOP**	Out Of Pocket
DACAAR	Danish Committee for Aid to Afghan Refugees	**OR**	Odds Ratio
DALYs	Disability Adjusted Life Years	**PH**	Provincial Hospital
DH	District Hospital	**PN**	Public Nutrition
EPHS	Essential Package of Hospital services	**PPWP**	Potable and Productive Water Project
EPI	Expanded Program on Immunization	**PR**	Prevalence Ratio
EU	European Union	**RH**	Regional Hospital
GAVI	Global alliance for Vaccines and Immunization	**RR**	Relative Risk

GDP	Gross Domestic Product	**Ru-WatSIP**	Rural water supply, sanitation and Irrigation Program
GMJs	Ghazanfar Medical Journals	**SD**	Standard Deviation
GWS	Global Water Strategy	**SDGs**	Sustainable Development Goals
HAZ	Height for Age zee score	**SUN**	Scaling Up Nutrition
HDI	Human Development Index	**TFR**	Total Fertility Rate
HP	Health Post	**THE**	Total Health Expenditure
HSC	Health Sub Center	**UNICEF**	United Nations International Children's Emergency Fund
IMCI	Integrated Management of Childhood illnesses	**USAID**	United States Agency for International Development
IMNCI	Integrated Management of Neonatal & Childhood Illnesses	**USD**	United States Dollars
IMR	Infant Mortality Ratio	**VU**	Vrije Universiteit Amsterdam (Free University)
IRR	Incidence Rate Ratio	**WASH**	Water, Sanitation, and Hygiene
KIT	Royal Tropical Institute (Koninklijk Instituut voor de Tropen)	**WAZ**	Weight for Age Z-score
LAZ	Length for Age Z- score	**WHO**	World Health Organization
LICs	Low-Income Countries	**WHZ**	Weight for Height Z-score
LMICs	Low- and Middle-Income Countries		
LPCD (lpcd)	litre per capita per day		
MMR	Maternal Mortality Ratio		

Abstract

Introduction: Afghanistan is a war-affected, mountainous and low-income country; where 17% of the population comprised of under-five children. Excluding the neonatal period; acute diarrhea accounted the first leading cause of death in under-five children. Nationwide diarrhea prevalence in under-five children ranged from 18-38%. The objective of this study was to assess; socio-economic and environmental factors as well as to review current policies and strategies regarding acute diarrheal diseases in under-five children in Afghanistan, moreover to provide recommendations for policymakers and researchers.

Methodology: It was a literature review; literature searched through various search engines like Google Scholar and PubMed from Afghanistan and low-and-middle-income countries. Analyzed by adapted Conceptual Framework "visualizing the inter-relationship between potential risk factors, the sanitation intervention and diarrhea prevalence 2008".

Results: This Study found; poor household economy, improper sanitation, improper hygiene practices, poor access to clean drinking water, mothers' low level of education and unemployment, children's poor nutrition, improper garbage collection, and disposal were the most important factors for diarrhea in under-five children in Afghanistan. Rural Afghanistan, poor people, and Kuchi populations were most affected.

Discussion: Despite having proper policies and strategies, there were gaps in implementation; especially in environmental health strategies. I recommend the following: advocacy for girls' education and employment, revision of environmental health policy and waste management strategies, researches to investigate cultural factors as well as 'houseflies around the house' and their association with under-five diarrhea in Afghanistan.

Keywords: Diarrhea, under-five children, risk factors, policies, Afghanistan

Word count: 12685

Introduction

I Dr. Jawaid Waak a medical doctor from Afghanistan, after graduation from Kabul Medical University in 2008; enrolled as a paediatric resident at Ataturk National children Hospital-Kabul; after successful completion; became a general paediatric specialist in 2012. Joined; Nangarhar Medical Faculty as a lecturer and a medical officer at University Teaching Hospital at the department of paediatrics, in the year 2013.

As from my own work experience; diarrhea was still one of the main morbidities in under-five children in the country with lots of mortalities in rural and remote areas, which were attributable to lack of qualified health workers and inadequate medicines especially in war-affected insecure districts. Though diarrhea was a preventable disease and despite the existing public and private health facilities, preventive programs, basic package of health services (BPHS) and essential package of hospital services (EPHS) programs; diarrhea was one of the main causes of malnutrition and the resultant complications. During my practice, I realized that we should work more on preventive side for any preventable diseases including diarrhea to have a major impact than to treat every single individual.

Globally; estimated 1.7 billion diarrhea cases occurred in children in 2010; with approximately 700,000 children deaths every year; moreover 98% of the deaths occurred in low-and-middle-income countries (1). The diarrheal mortality rate in under-five children was 70.6 deaths/ 100,000 populations in 2016 and the highest rates were in sub- Saharan Africa and South Asia (2).

In Afghanistan; diarrhea was the fourth leading cause of deaths in under-five children (14% of all under-five deaths) (3, 4). According to a survey in 2015; Diarrhea prevalence in under-five children was 29% but in children aged 12-23 months this was 38% (5). Not only deaths but diarrhea could cause varieties of morbidities and complications, low productivity and financial burden on the households (as mentioned in problem statement). Thus, diarrhea was still a major public health problem in Afghanistan, which needs proper attention and possible alternative solutions to reduce under-five morbidities and mortalities.

Besides the motivation and enthusiasm that I have to the child health, my years-long professional experience in paediatric clinical medicine can be an added advantage of the subject matter. Therefore with knowledge, experience, and current need; I selected this thesis topic for partial fulfilment of MPH degree at KIT.

The dissertation comprises of five chapters; Chapter 1-Background Information of Afghanistan, Chapter 2-Problem statement, research objectives, justification of the research and methodology, Chapter 3- Socio-economical, environmental and nutritional factors, 4-Policies, Strategies, and WASH interventions, chapter 5-Discussion, conclusion, and recommendations.

Chapter One

Background Information on Afghanistan

1.1- Geography

Afghanistan is one of the land-locked countries; which is located at the south-west corner of Central Asia with 650,000 kilometre square area, surrounded by Uzbekistan, Tajikistan and Turkmenistan on the north; on the west by Iran; on the east and south by Pakistan and at the extreme north-east by the People's Republic of China. It has 34 provinces which are subdivided into 387 districts and the capital is Kabul city (see annex 1) (6, 7, 8). Almost 98.8% people are Muslims; Pashto and Dari are the formal languages (7). Approximately 80 percent of the land is occupied by mountains and deserts; the forests constitute only 2% area of the country (9). The climate varies from arid to semi-arid with cold winter and dry and hot summer. The lowest temperatures are in the northeast mountainous areas up to $-15C^0$ and the southern parts have the highest temperature up to $49C^0$. Two third of the country land is mountainous which divided the country by different geographic regions such as Northern- plains, Central highlands, South-western plateau and eastern highland slopes (6, 7).

1.2- Demography

The total population of Afghanistan till 2018 was 31.6 million (16.1 million males and 15.5 million females), Almost 5.4 million of the population (17.1%) comprised of under-five children (8); but according to World Bank data from 2018 total population of the country was approximately 37.17 million (10). Almost 71.5% of the population lived in rural areas and 23.7% lived in urban areas; 4.8% were Kuchi population (nomads) (8). According to a survey in 2015; the majority of the population were young; under the age of 15 years (47%) and only 3% of the population were 65 years old or above (5). The annual average population growth rate from 2010 to 2015 was 3.2% (11). Total fertility rate (TFR) was 5.1 children per woman and general fertility rate/year was 159 live births**/**1000 women in reproductive age in 2018 (4). The average size of a household in the urban and rural areas was 7.35 members in 2018 (4).

1.3- Education

According to a survey in 2015; only 31% of females (almost half of the males) aged 6 years and older have ever attended school; only 10% of males and 4% of females have completed secondary school or gone beyond (5). Similarly, in 2018 almost 70% of women and less than 50% of men never attended school (4). Net school attendance ratio (NAR) in primary school was 69% for boys and 50% for girls aged 7-12 years (5). The adult literacy rate was 49.4% in males and 19.9% in females in 2016 (12).

1.4- Political Environment

Afghanistan remained a zone where the territorial interests of Britain and Russia clashed; it has become a zone of recurrent armed and political conflicts in the nineteenth century as well as the growing American interests in this region (6). The failure of Afghan regime to incorporate disputed northwest- frontier and Baluchistan districts of Pakistan into its own territory, was the other factor that Pakistan and western had interests in; and caused the prolongation of war for more than four decades up to present (6, 13, 14).

In the 1990s; after the victory by the Jihadists (religious warriors); civil war started between different groups, resulted in the destruction of government and political structures. In 1996 another religious group in the name of Taliban came into power and ruled till 2001, which later on collapsed by American direct invasion; subsequently, International Security Assistance Forces took the power and established a new interim government and then a republic government; a newer constitution was endorsed, for the first time parliament members and the president elected through elections (13, 14, 15).

The current unity government which led by President Mohammad Ashraf Ghani and Chief Executive Officer Dr. Abdullah Abdulla was established in 2014, through general elections and signed the bilateral security agreement with the United States which could help increase international assistance to the country. Still, Taliban and different insurgents groups were active in the country that threatened the government, as well as political clashes between the politicians ultimately led to instability, corruption, unemployment, poverty, and dependency on foreign aids (14, 15, 16).

1.5- Economy

Afghanistan is one of the low-income countries (LICs), almost 54.5% population lived below the national poverty line in 2016 and gross domestic product (GDP) per capita was 747 United States Dollars (USD) and total health expenditure (THE) per capita was 70.9USD (10, 17). Afghanistan ranked low as169; in the human development index(18). Though economy of the country expanded on an average rate more than 5% from 2011-2015 but the annual GDP growth rate acutely dropped from 14% in 2012 to 1.3% in 2014 and 1.9% in 2015; the reduction in foreign aids and 0% foreign investment because of insecurity, disrupted governance and conflicts were the possible reasons and the condition will deteriorate more if the political instability remains the same or get worse (16).

1.6 - Health system in Afghanistan and key stakeholders

The lead institution responsible for the health of the entire population is the ministry of public health (MOPH). Some other ministries and agencies also directly or indirectly involved in the implementation of health-related activities too. Non Governmental Organizations (NGOs), development partners, professional associations, regulatory bodies, and private sector facilities and institutions are also key stakeholders in the health sector (16).

After the collapse of Taliban regime in 2001; lack of health infrastructures, lack of human resources for health, low availability of the health service delivery and lack of proper health policies were the main challenges which caused worse health indicators in the country (19, 16). The MOPH developed and implemented; two important strategies as BPHS and EPHS in 2002 and 2005 respectively; based on a contract by NGOs. Nearly 2300 health facilities were the core of PBHS and EPHS along with some provincial hospitals in the country which mentioned in table-1(16, 20).

Table 1: Types of health facilities in Afghanistan (16).

Service Facility Type	Number [15]
Regional and national hospital	6
Provincial hospital	28
District hospital	80
Special hospital	29
Comprehensive health center	405
Basic health center	834
Sub-health center	579
Mobile health team	147
Health post	15,175

NHS 2016-2020

Along with the above-mentioned facilities; a large number of private sector facilities were operating which caused high out of pocket (OOP) health expenditure of 74% by the people (16). The MOPH is the state institution; strengthens the governance of the health sector and institutional development (16).

Remarkable progress in improving the health status of the people has been made since 2001 by strong support from the development partners and donors as the result of improvement in access, quality, and coverage of health services. Life expectancy at birth increased from 42 years in 2002 to 64 years in 2012; Accessibility to basic health services (preventive and curative) within one-hour walk distance increased from 9% in 2002 to 57% in 2012 (16). Infant mortality ratio (IMR) in 2005 has declined from 66 to 45 per 1000 live births in 2015. From 2010 to 2015; under-five mortality decreased from 87/1000 to 55/1000 live births and maternal mortality ratio (MMR) from 1600/100,000 to 396/100,000 live births (16).

1.7- National Health Policies, Strategies and Development Partners

National Health policy 2015- 2020reform was to change the culture and functioning of the MOPH and health structures to reduce preventable morbidities and mortalities and to achieve a sustainable and better impact on the health of the population for achieving the Sustainable Development Goals (SDGs).

To achieve these objectives; domestic resource allocation to health sector should be increased; accessibility, equity, partnerships, sustainability and quality of health services should be strengthened through the framework of good governance, cost-effective public

health, institutional development, effective human resources development, and inter-sectoral collaboration. So, this policy required; the broad national health strategy 2016-2020 to focus more on the last five policy items. Developing partners for delivering BPHS and EPHS services were; United States Agency for International Development (USAID), European Union (EU) and World Bank (16, 20, 21).

After the comprehensive assessment and review of the previous health strategy 2011-2015 some shortcomings and challenges identified; based on the findings, the National Health Strategy 2016-2020 developed. This strategy had clear and specific results, outputs and associated targets as well as Specific implementation plan, Annual Action Plan with clear implementation mechanism layout; moreover it had joined mid-term, end-term and annual reviews along with the monitoring and evaluation (M&E) framework for national impact and output level results. Monitoring was going to be done on a monthly, quarterly, semi-annually and yearly basis (16).

1.8- Structure of Health Care Service Delivery

The overall structure of the health care system in Afghanistan is similar to other systems in low-and-middle-income countries (LMICs) and is as follows (see Figure-1):

1.8.1- Health Post (HP): This is the most peripheral level of contact with the patient at the community level. Community health workers (CHWs) as non- professional health service providers were the first point of contact from their homes. Staffed by one female and one male CHW assigned for 1000-1500 people (20).

1.8.2- Health Sub-centre (HSC): Mostly established in difficult geographical locations. Each HSC is staffed by a male nurse and a community midwife and covers 3000- 7000 population in its catchment area (20).

1.8.3- Basic Health Center (BHC): A small facility that provided comparatively more complex outpatient services, and supervised HSCs and HPs; included routine immunization, integrated management of childhood illness (IMCI) including diarrhea. Each one was staffed by one community midwife, a nurse, and two vaccinators and covered 15000- 30000 population (20).

1.8.4- Comprehensive Health Center (CHC): Limited capacity for the inpatient services. Staffed by nurses, midwives, vaccinators, a male and a female medical doctor pharmacy and laboratory technician. Could handle some complicated cases of childhood illnesses and could perform minor and essential surgeries and covered 30,000- 60,000 populations (20).

1.8.5- District Hospital (DH): Was a bridge between BPHS and EPHS; functioned as a referral hospital too and provided broader medical care. Beside other staff; they included obstetrician, paediatrician, anaesthesiologist, surgeons and could handle more complicated cases. Covered 100,000– 300,000 population in its catchment area (20).

1.8.6- Provincial Hospital (PH) & Regional Hospital (RH): They were referral hospitals and had specialists and provided more sophisticated medical care. RHs were more professional in in-patient services and emergency-care (20)

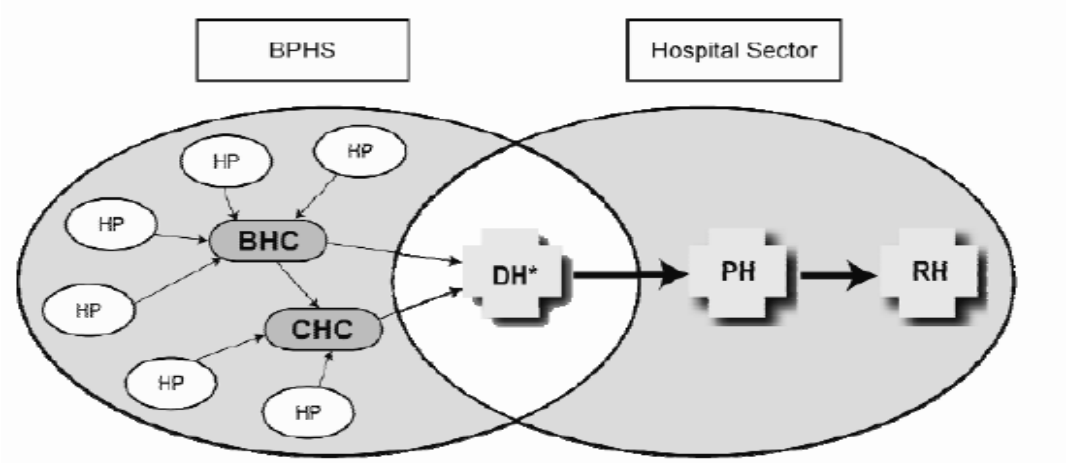
1.8.7- National or Specialized Hospital: They were also referral hospitals and mostly located in the Capital and besides medical care, they trained specialists too (20).

CHWs were involved in diagnosis and treatment of diarrhea from their homes as well as they provided micronutrient supplementation too. A limited number of medicines allowed for them and they did recognize the danger signs and refer the needy (20).

Basic maternal and newborn health (MNH) services; as Anti Natal Care (ANC), delivery care, neonatal care as well as diarrheal diseases care done by different levels of BPHS (HSCs, BHC, CHCs and DHs) by health professionals like doctors, nurses, and midwives (20).

Beside services mentioned above; DHs, PHs, and RHs were referral hospitals and involved in specialized care for childhood illnesses and complications (20).

Figure 1: The Links between various health facilities in Afghanistan (20).



Source: MoPH (2006)

Chapter Two

Problem Statement, Justification, Objectives and Methodology

2.1- Problem statement

Worldwide; 1.7 billion estimated diarrheal cases occurred in children in 2010, more than 700,000 children deaths were because of diarrheal diseases annually; of which 98% occurred in LMICs, diarrhea accounted for 11% of under-five deaths and was the leading cause of DALYs (disability-adjusted life years) among all age groups in 2015 (1, 22, 23). In 2016 diarrheal mortality rate in under-five children was 70.6 deaths/100,000 population, as well as diarrhea, accounted the fifth leading cause of death in this age group. Though the number of diarrheal deaths decreased by 56.5% from 2000 to 2016 in this age category but still was a big problem in LMICs (2). The passage of three or more loose stools or frequent loose stools than normal per day for an individual which last less than 14 days is called acute diarrhea (24).

Afghanistan was also one of the LMICs; where diarrheal diseases and its consequences significantly affected the population health; especially in under-five children. To be compared to the world; diarrhea was also the fourth leading cause of death in this age category (diarrhea accounted for 14% of under-five deaths) (3, 4); but excluding the neonatal period (first month of life) the first leading cause of death in this age category (25.1% of all deaths) (4). According to a survey in 2015, Diarrhea prevalence in under-five children was 29% (another survey in 2018 showed; prevalence was 18% but the sample size was lower) and in children aged 12-23 months prevalence was 38% (4,5); moreover according to a report; diarrheal incidence was 6.2% in 2016 (25).

Southern and western zones of the country had comparatively higher cases of diarrhea than the north and east zones in 2015 (19). According to a study from sentinel sites in Afghanistan; from 2007 up to 2015; acute watery diarrhea, related deaths decreased from 4.6% to 1.7% as well as because of acute bloody diarrhea from 1% to 0.1% (19).

According to World Health Organization (WHO) in 2001; outbreaks of specific type of acute diarrhea (Cholera) were reported from the north, northeast, south and southeast zones of Afghanistan; approximately 5000 people of different ages were infected and led to 114 deaths (26); furthermore four new outbreaks also reported from the country in 2016 (25).

Diarrhea could cause dehydration and death (24). Furthermore; mental, developmental, growth, psychological, economic, nutritional and immunological (decreased vaccine efficacy) consequences were associated with diarrheal diseases; which affect the overall health status of the child, family and the country (1). Studies revealed that diarrhea could cause malnutrition and malnutrition could cause susceptibility of devastating infections and recurrent diarrhea (a vicious cycle) (27). It is worth mention that, recurrent diarrheal episodes could lead to direct medical, direct non-medical, indirect and opportunity costs;

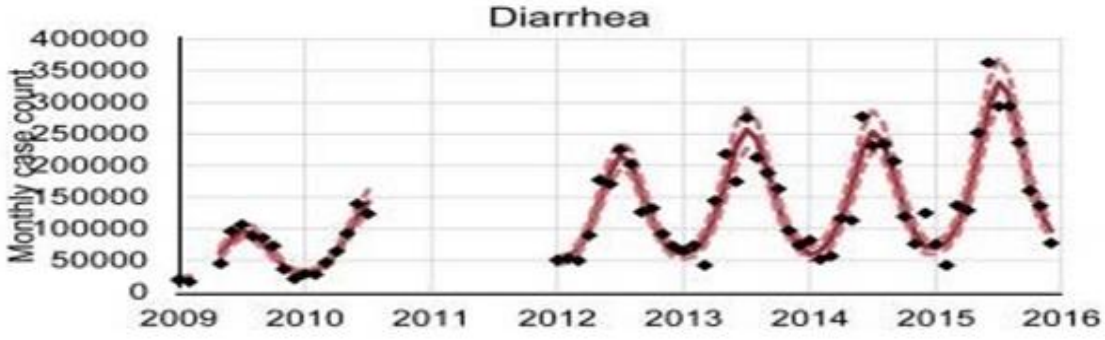
which further made households susceptible to substantial economic burden, poor nutrition, malnutrition and its consequences (28, 29).

Studies have shown that many types of viruses, bacteria, and parasites were the causative agents and the most incidences of moderate to severe diarrhea caused by rotavirus, cryptosporidium, shigella and enterotoxigenic E.coli (1). The main routes of transmissions for diarrheagenic agents were contaminated water and foods (fecal-oral transmission); such as transmission by flies, ingestion of contaminated water or foods and person to person contact because of poor hygiene (1, 24). Elyan D. et al identified that rotavirus was the common cause of under-five diarrhea in Afghanistan in 2014 (72.2% of all diarrhea caused by rotavirus) (30).

Seasonal variations documented in diarrheal incidence as 5% in winter which increased to 18% in summer; the hot climate was also a contributing factor in south and west regions (19). Though; diarrhea existed throughout the year but most cases occurred in summer and early autumn (31). Malnutrition, immune deficiency, younger age, mothers low level of education, contaminated environment by the causative agents, unavailability to improved or clean water, family size, unavailability of proper sanitation facilities and shared toilets, poverty, poor hygienic practices, contamination of foods by flies and starting up complementary feeding were some risk factors which contributed to diarrheal diseases; especially in under-five children (4,5,24).

Studies have shown that WASH (Water, Sanitation and Hygiene) programs as availability of improved water supply, good hygienic care and hand washing with soap and a proper system of sanitation could prevent all diarrheal episodes by 95% (1, 32). Another study showed that these measures could reduce diarrheal mortality by an average of 65%; as well as could increase school attendance, performance, productivity, and overall wellbeing and reduced health expenditure and costs (29). A study predicted that 40% deaths because of rotavirus could be prevented if all 43 Asian countries had introduced its relevant vaccine (33).

Figure 2: The yearly trends of acute diarrhea in Afghanistan from 2009- 2015 (31).



Observed and modelled data from diarrhea in Afghanistan's Disease Early Warning System 2009- 2015.

2.2- Justification of the Research

As mentioned in the problem statement; acute-diarrhea in under-five children; was still a major public health problem in Afghanistan too.

Up to present; no any specific research was done on the topic in Afghanistan, and despite implementation of BPHS, EPHS and preventive programs for more than one and half decade and availability of private sector institutions; diarrhea incidence, prevalence, and mortality remained higher; even incidence increased from 2009 to 2016 (figure-2) (31).

To achieve the SDG#3; Target 3.2 "to end preventable deaths of newborns and under-five children by 2030"; there was strong need to have in-depth knowledge about socio-economical and environmental determinants of diarrhea in Afghanistan.

Moreover; to review the current preventive policies, strategies and interventions; regarding diarrheal diseases in Afghanistan to find the gaps. And to propose new context-specific recommendations for policymakers and relevant stakeholders to contribute to contain and tackle the problem, that will lead to a decrease in diarrheal morbidities and related consequences; ultimately to improve the overall health of the children and the population for better performance and productivity in their life cycle.

2.3- General Objective

To assess socio-economical and environmental factors contributing to the occurrence of diarrheal diseases in under-five children and to review the current diarrhea-related policies and strategies in Afghanistan to provide recommendations for policymakers and stakeholders regarding controlling diarrheal diseases in the country.

2.4- Specific Objectives

Specific objective-1: To assess socio-economical and environmental factors contributing to diarrheal diseases in under-five children in Afghanistan.

Specific Objective-2: To assess the role of feeding, breast feeding and nutritional status of the child in occurrence of diarrheal diseases in under-five children in Afghanistan.

Specific Objective-3: To review the current policies and strategies regarding controlling diarrheal diseases in under-five children in Afghanistan; including WASH interventions.

Specific Objective-4: To provide context specific recommendations for policy makers and relevant stakeholders, regarding controlling of diarrheal diseases in under-five children in Afghanistan.

2.5- Methodology:

2.5.1- Study Design

This study was a literature review, conducted based on published articles and gray literature. Search engines such as; PubMed and Google Scholar were used to find the relevant published articles and some articles accessed through Vrije University (VU) E-library; while gray literature (reports, papers from conferences and policy documents) were accessed through Google and various institutions websites (MOPH, WHO, World Bank, Central Statistic Organization (CSO), Ghazanfar Medical Journals (GMJs), USAID, UNICEF and KIT...). Based on the research question and study topics, relevant articles searched, reviewed and then the findings summarized and reported.

2.5.2- Search Strategy and Key Words

Keywords have been used to search the relevant articles through various sources indicated above.

Multiple and dual combinations of the key words were used which connected with each other by 'AND' or 'OR' or 'NOT' for obtaining desired articles; such as "Afghanistan" AND geography, "Afghanistan" AND demography, "political environment" AND Afghanistan, "risk factors" AND diarrhea OR diarrhoea, "demographic and health survey" AND Afghanistan, "diarrhea" AND under five OR U5, "Acute diarrhea" AND Afghanistan, "diarrhea policies" AND Afghanistan, "diarrhea strategies" AND Afghanistan, "Diarrhea" AND under-5 years, "diarrhea" AND under-5 AND Afghanistan, "Under five diarrhea" AND low- and- middle income countries, "diarrhea" OR diarrhoea AND WASH, "WASH" AND Afghanistan, "acute diarrhea" NOT chronic, "diarrhea"[chronic] OR diarrhoea AND LMIC, "diarrhea" OR diarrhoea AND less than five, "Acute diarrhea" AND worldwide, "diarrhea" AND under-five AND Pakistan, "diarrhea" AND living condition OR diarrhoea, "associated factors" AND diarrhea AND Bangladesh, environmental factors* AND diarrhea OR diarrhoea etc (see annex 2).

2.5.3- Inclusion and Exclusion Criteria

Published articles relevant to research objectives were used in this study from January 2000 to July 2019 (a few articles from earlier than 2000). Only the articles from Afghanistan and LMICs that contained keywords; either in the title or in the abstract were included in the study. All of them had to be published in English, Dari or Pashto. Articles with abstracts- only and case- studies were excluded.

2.5.4- Methodological strengths and limitations

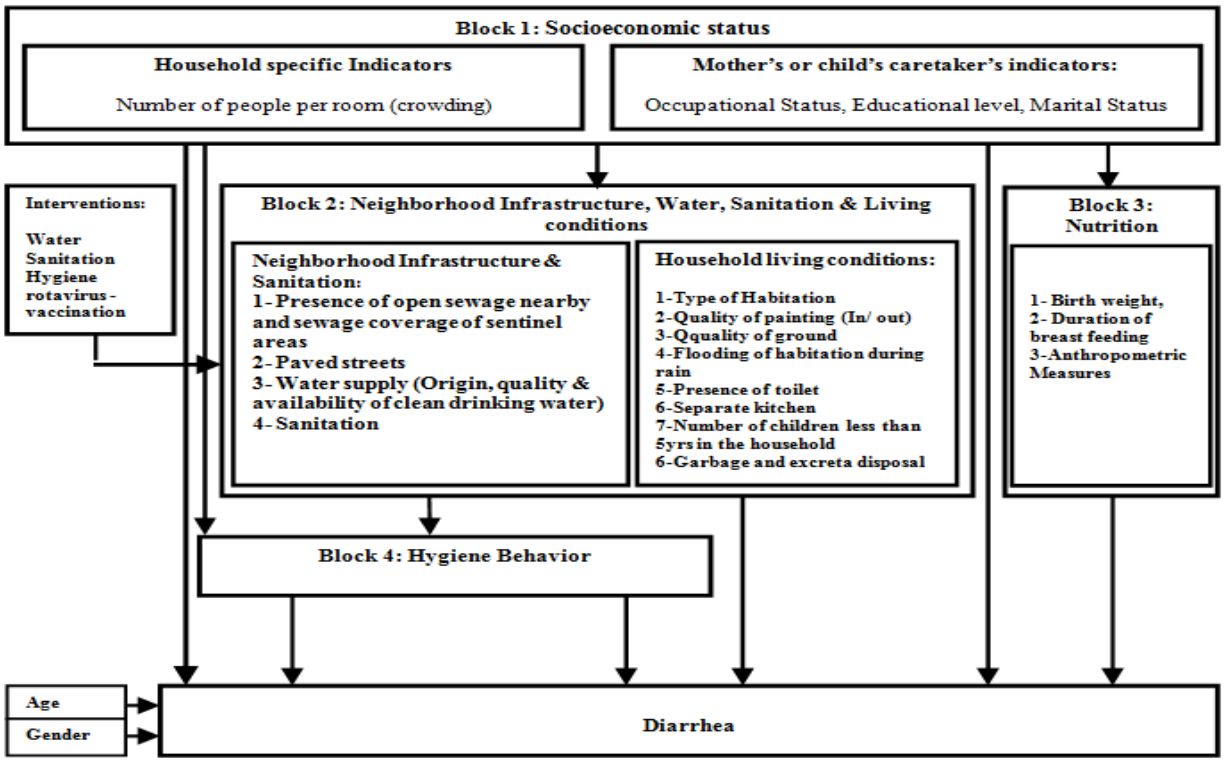
Limited studies found, related to acute diarrhea in under-five children for Afghanistan. Moreover, articles in local languages could not be found as most of them published in local medical- magazines; not online. This study was done in limited time frame and was a quick review and the findings will be helpful to facilitate further researches. No any article found to show the association between household-flooding and diarrhea in Afghanistan during rainy seasons, nor Demographic and Health Surveys (DHS) mentioned anything about it. Key terms and definitions are described in Annex-4.

2.5.5- Conceptual Framework

A number of conceptual frameworks related to socio-economical and environmental determinants of diarrhea, social determinants of diarrhea and Wash interventions were reviewed. Dahlgren & white head social determinant of health rainbow model (1991) (34), framework of childhood diarrhea by Remidius Kamuhabwa Kakulu in Tanzania 2012 (35),"proximate determinants model" for control of diarrheal diseases (36), Cultural model of diarrheal illness (37) "Conceptual framework visualizing the inter-relationship between potential risk factors, the sanitation intervention and diarrhea prevalence 2008" (38) and adapted model of Wagner and Lanoix 1958 (39), reviewed.

The "Conceptual framework visualizing the inter-relationship between potential risk factors, the sanitation intervention, and diarrhea prevalence 2008" for impact of sanitation intervention on social, environmental and behavioural determinants of childhood diarrhea; found to be the most suitable for this study (38). It included social, economical and environmental factors which were in line with the objective of this study. However few modifications were made. Block 5 (intestinal parasitic infections) section was removed as it was out of the scope of this study. From literatures, it was found that rotavirus vaccination, water and Hygiene interventions were also very important thus added to the sanitation intervention section. The generic version of this model is attached as annex (see annex- 3). The adapted and modified model used in this study showed in Figure-3.

Figure 3: Adapted Conceptual Framework from "Conceptual framework visualizing the inter-relationship between potential risk factors, the sanitation intervention and diarrhea prevalence" (38).



Impact of Sanitation intervention on social, environmental and behavioural determinants; of childhood diarrhea-2008.

Chapter 3

Socio-economical, Environmental and Nutritional Factors

This chapter examines the first and second objectives of this study with the help of the conceptual framework used for this study. Socio-economical and environmental factors, as well as the role of feeding, breastfeeding and nutritional status, are presented below:

3.1- Socio-economical status

3.1.1- Household specific indicators

3.1.1.1- Number of people per room (crowding)

People who lived in dwellings, that had fewer rooms or more people lived per room had a higher chance of getting diarrheal diseases than those who had more rooms. A study from Ethiopia in 2017, showed a positive association between less living rooms for a family and high diarrheal morbidities in children; those families who had one room partition for living compared to those who had three or more rooms, were 1.7 times at increased risk of getting diarrhea (OR= 1.8; 95% CI: 1.10- 2.87) (40). A study in Yemen in 2018, also demonstrated a strong positive association between large family size and high prevalence of diarrhea ($P < 0.0001$; family size > = 5) (41).

According to a nationwide survey in Afghanistan in 2015; only 48% of the families had 3 or more rooms for living and sleeping and 16.4% of the households had only one room for living and sleeping (5). In 2018; average size of a household in the urban and rural areas was almost the same as 7.2 to 7.5 members respectively (4). Comparatively another survey in 2016 revealed that at national level; 3.2 persons lived per room but this number was much higher in Kuchi population as 5 persons per room. Almost 43.9% of the population lived in overcrowded housing conditions, comparatively, it was 83.3% in Kuchi population (12).

3.1.1.2- Economical status of the household

A meta-analysis in India in 2015 showed that; there was a strong association between low socio-economical status of the household with high risk of diarrhea in children; odds ratio (OR) = 7.14 (95% CI: 2.19- 23.32) (42). Similarly a study in 2005 in Ghana also showed that poor children were more vulnerable to diarrheal diseases because of lack of latrines or shared toilets (43).

Poor socio-economical status could deprive the households, of proper living conditions and housing, availability of clean drinking water, proper sanitation facilities, hygiene practices and hands washing with soaps, on-time access to health care services, proper nutrition, access to transportation, high level of education and better opportunities to find a job and having sufficient income; as discussed in the next sections; all had significant association with the occurrence of diarrheal disease, other morbidities and related mortalities (1,40).

In Afghanistan approximately 54.5% of the population lived below the national poverty line in 2016 and GDP per capita was 747 USD and total health expenditure per capita was 70.9 USD; it is worth mention that because of high OOP expenditure (72% of THE) and high medical costs; often people preferred to not seek care on-time while needed that led the diseases to be more complicated, chronic and ultimately may end with death (10, 17).

3.1.2- Mother's or child- caretaker's indicators

3.1.2.1- Occupational status of the mother or child-caretaker

Occupation and employment of the mother or caretaker could affect the socio-economical status (especially income status) of the family and vice versa.

A study in Brazil in 2018 showed that those families who had high income; the maternal self-efficacy to prevent childhood diarrhea was high compared to households with low income (significant association with the income level; P= 0.042) (see annex-4) (44). Comparable results also came from multivariate analysis of data from another study in Senegal in 2014; it showed that the risk of diarrhea among under-five children of mothers with no occupation (housewife) was 1.62 times higher than those who were employed (OR=1.62; 95% CI: 1.18- 2.23) (45).

According to a nationwide survey in 2015; only 12% of ever-married women aged 15-49 years were employed at the time of the survey and mothers were the main caretakers of their children (5).

Unemployment also contributed to poor household economy and the resultant poor health outcomes including diarrhea. As a vicious cycle poor economy caused poor health and low level of education, thus lower chances of employment and the resultant poor household economy; which further make the household vulnerable to poor nutrition, poor living conditions, poor infrastructure, thus high chance of diarrheal diseases (12, 40).

3.1.2.2- Education level of the mother or child-caretaker

Mother's or caretaker's education level was also an important factor for diarrhea in under-five children. A cross-sectional study in under-five children from four zones of Senegal in 2014; showed that low level or no education of the mothers or caretakers was significantly associated with high prevalence of diarrhea (diarrhea prevalence in children of mothers with no education ranged from 38%-58% and of mothers with secondary or higher education ranged from 15.4%- 25.9%; P< 0.001) (45). Comparable results came from another study in Ethiopia in 2016; as the likelihood of occurrence of diarrhea was 2.5 times higher in those children, whom mothers had no formal education compared to those who had at least secondary education (OR= 2.5, 95% CI: 1.2-5.2) (46).

Furthermore a systematic review in India in 2015; also showed a significant association between mothers low level of education (1-10 years) and increased risk of diarrhea in under-five children (OR= 1.43, 95% CI: 1.06-1.93)(42).

A survey in Afghanistan in 2015; revealed that diarrhea prevalence was also much lower in children whose mothers had secondary or higher education level compared to those with primary education (18% versus 33% respectively) (5). Only 10% of women in urban areas and 2% women in rural areas had completed secondary school in Afghanistan as well as education attainment by women in rich households was higher than the poor (13% versus 1% respectively) (5). According to another survey in 2016; Literacy rate in adult men and women (15 years and older) was 34.8%, and almost 6 million adult females were illiterate in the country (12). Furthermore; poor socio-economical status, cultural barriers, and geographical factors were also contributing to the high illiteracy rate in adult females (5, 12).

3.1.2.3- Marital status of the mother or child-caretaker

Marital status of the mother or caretaker was not found to be a determinant of under-five diarrhea. A study in Ethiopia in 2018 showed a no-significant association between marital status and prevalence of diarrhea (p= 0.285, only negative significant association found (protective) in widows (p=0.01, 95% CI: 0.089-0.762)) (47). Comparable results came from another study in Senegal in 2014 which support no-association between under-five diarrhea and marital status (45).

According to a survey in Afghanistan in 2016; almost 35.6% of females were married, 4% widowed and 57.8% never married nor engaged (12).

3.1.2.4- Mother's age

Mother's age was also an important risk factor for diarrhea in under-five children. A study in Yemen in 2010; showed a significant positive association between mother's age <18 years (early married mother) and high prevalence of diarrhea in their children compared to those mothers ≥ 18 years old (AOR=2.09, 95% CI: 1.89-2.51) (48). Similarly a study in Brazil in 2008 showed that the likelihood of contracting diarrhea was higher in children of those mothers whose age was less than 18 years compared to those who were above 18 years (AOR=1.27, 95% CI: 1.04-1.54) (49).

A survey in Afghanistan in 2016 showed that mean age for first marriage in women was 21.6 years and 28.3% girls married before age 18 years in the age category 20-24years (total married women in this category were 37.9%) (12). Socio-economical status, low education level, cultural and gender issues could contribute to early marriage especially for girls (5,12).

3.2- Neighbourhood infrastructure, Sanitation & Living conditions (environmental Factors)

3.2.1- Presence of open sewage nearby and sewage coverage of sentinel areas

Open sewage system was also an important determinant of diarrhea in under-five children. An analysis of two cohort studies in children 0-36 months; in Brazil in 2008; showed that the prevalence of diarrhea in the exposed group (open sewage nearby house) was higher; the prevalence ratio (PR; exposed versus non exposed group) was 1.47 (95% CI: 1.34-1.60) and an excess diarrhea risk of 10% was attributable to open sewage in the exposed group; sewage coverage intervention (connection to sewer) of sentinel areas reduced the attributable risk of diarrhea by 28% and had higher protective effect than individual household intervention (38).

Comparable results came from community- based survey from Gaza Strip in 2014; which revealed the prevalence of diarrhea was 22.5% (in last 24 hr) in households with open sewage system nearby, compared to 16.8% with closed sewage system (50). Similarly another study in Yemen in 2010; also showed significant positive association between open sewage system and high prevalence of diarrhea (AOR=1.19, 95% CI: 1.01-1.49) (48). But another study in Nepal in 2010 showed no-significant association between unhygienic blocked drainage around the house and increased risk of diarrhea (AOR= 2.03, 95%CI: 0.22-1.11) (51).

In the year 2016 in Afghanistan; only 1.5% of the population at the national level had a piped sewer system (12).

3.2.2- Paved streets in the neighbourhood

A study in Brazil in 2008 showed weak positive significant association between unpaved neighbourhood streets and higher prevalence of diarrhea in children compared to paved ones (PR= 1.14, CI: 1.04-1.24) (38). A systematic review in 2013 from LMICs; showed no- significant association between paved streets and change in communicable disease outcomes including diarrhea (Relative Risk (RR) = 0.98, 95%CI: 0.85-1.14) (52).

As 71.5% of the population live in rural areas and they don't have any paved streets and along with much improvement since 2001; only a few streets of only major cities paved till 2016 in Afghanistan (8,12,53). Poor socio-economical condition of the country, conflicts, insecurity and poor governance were the main reason for poor urban and rural development projects (5,12,53).

3.2.3- Water supply (Origin, Quality, and availability of clean drinking water)

Quality of water was mostly dependent to the source of water (improved drinking water sources were of good quality and assumed as clean drinking water, and water from unimproved sources could only be used in specific settings after treating or filtering them)

(see annex-4). Availability of improved drinking water and consumption quantity (per person/day) were also very important determinants of diarrhea. A large number of studies around the world have shown strong association between unimproved or contaminated drinking water and increased incidence and prevalence of diarrhea in under-five children.

A study from Ghana in 2005 showed that the source of water, had a significant association with the incidence of childhood diarrhea; as the incidence was 7% in children of households with private indoor pipe, 17.1% with shared standpipe among nearby households, 33.1% who got water from vendor and 37.5% in children of households who got water from other than mentioned sources (p=0.002, 95% CI) (43). Comparable results also came from another study carried out in Cambodia in 2013; which showed that incidence of diarrhea among children was 33% higher who drunk surface water (95% CI) compared to those who drunk improved drinking water (54).

A study in Ethiopia in 2014 showed; slightly positive significant association between high diarrhea prevalence and round trip of 30 minutes walking time or longer distance for mothers to collect water; adjusted odds ratio (AOR) = 1.65 (95% CI: 1.01-2.68); it meant that the longer the distance the less amount of water collected, the higher the chance of contamination while transporting or storing and the higher risk of diarrhea (40). A systematic review in 2015 from LMICs demonstrated a positive association between less quantity of water consumption per person per day (litre per capita per day (lpcd)) and higher diarrheal morbidities. More specifically one study in Nepal showed water consumption < 20 lpcd was significantly associated with high diarrhea (OR= 2.53, 95% CI: 1.10-6.33), moreover studies from 3 African countries showed that incremental increase of 1 lpcd of water consumption had protective effect against diarrhea (OR= 0.96, 95% CI: 0.93- 0.98) (55).

Access to only improved drinking water source could reduce diarrhea morbidity by 21% in under-five children (56). A systematic review in India in 2015 revealed that; use of solar disinfected drinking water had a protective association with diarrhea; incidence rate ratio (IRR) of 0.64 (95% CI: 0.48-0.86) (42).

A survey in Afghanistan in 2015 showed; overall 65% of the population had access to an improved water source (5). According to another survey in 2016, at national level only 36% of the population had access to safely- managed water source (improved drinking water source located at premises), 75.3% of the urban population, 25.1% of rural population and 3% of Kuchi population had safely managed water source (see table-2) (12). Another survey in 2018 showed that 75% of the urban population and 45.9% of the rural population had water inside their houses (4).

Table 2: Population by the residence and by drinking- water service (in percentage) in Afghanistan in the year 2016 (12).

Residence	Safely managed[a]	Basic services	Limited services	Un-improved	No service	Total
National	36.0	26.6	1.3	22.1	14.1	100.0
Urban	75.3	15.6	0.5	4.8	3.7	100.0
Rural	25.1	30.2	1.3	26.6	16.8	100.0
Kuchi	3.0	28.5	4.3	40.4	23.8	100.0

[a] Proxy indicator for drinking water from improved water sources located on premises, not considering water availability and eventual contamination assessed prior to its use by household members.

Safely managed: Drinking water from an improved water source that is located on premises, available when needed and free from fecal and priority chemical contamination
Basic services: Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing
Limited services: Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip, including queuing
Unimproved: Drinking water from an unprotected dug well or unprotected spring
No service: Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal

ALCS 2016- 2017

3.2.4- Sanitation

As mentioned earlier; transmissions of diarrheagenic agents were mostly by the fecal-oral route. Only improved sanitation itself could reduce diarrheal morbidities in children aged 3-36 months by 37.5% (56). Hereinafter; availability of improved sanitation facilities (see annex-4) could be very effective for prevention of diarrheal diseases.

According to a study in children in 2005 in Ghana; the incidence of diarrhea in households with no-toilet was the highest as 63% to be compared to any types of toilets (incidence ranged from 4.9%- 30.4 % from flush toilets to public toilets); as well as, diarrhea incidence was also higher in children of the households where open defecation was practiced in the neighbourhood (43). Furthermore a study in Ethiopia in 2012 also showed that children of households who did not have a toilet were more likely to develop diarrheal diseases compared to those who had toilets (AOR=1.64, 95% CI: 1.12-2.41) (57).

Similarly analysis of two cohort studies in Brazil in 2008; showed that 18% reduction in diarrheal risk was attributable to sanitation and infrastructure interventions (38). Comparable results also came from another study in India in 2013; which showed; diarrhea incidence was 24% higher in children in households without improved sanitation than those with improved sanitation (P= < 0.05) (58). Open sewage and absence of connection to sewer systems were also contributing factors for high prevalence of diarrheal diseases (38).

According to a survey in 2016 in Afghanistan; only 41.4% of the households at national level, 56.5% of the urban population, 38.8% of the rural population and 6.7% of the Kuchi population had basic sanitation facilities (improved sanitation facility not shared with other households); however in nine provinces less than 20% of the households had access to basic sanitation (12). Afghanistan was far behind the SDG#6.2 as "by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation,

paying special attention to the needs of women and girls and those in vulnerable situations". Different types of toilet facilities and defecation practices in Afghanistan have been shown in Table-3. Another survey in 2018 showed that 53.9% of the urban and 10.7% of the rural households had flush type of toilets but more than 98 % of them not connected to a closed sewer system (4, 12).

Table 3: Population, by main toilet facility and by residence (in percentages)in Afghanistan in 2016 (12).

Main toilet facility	Urban	Rural	Kuchi	National
Total	100.0	100.0	100.0	100.0
Pit latrine - with slab / covered pit	8.7	17.2	2.8	14.5
Pit latrine - without slab / open pit	15.1	35.9	7.4	29.5
Ventilated improved pit (VIP) latrine	13.7	6.9	0.0	8.2
Flush to piped sewer system	4.5	0.6	0.0	1.5
Flush/pour flush toilet to septic tank	33.7	1.1	0.0	8.8
Flush/pour flush toilet to pit	4.1	0.3	0.0	1.2
Flush/pour flush toilet to elsewhere	0.7	0.1	0.0	0.2
Single/double vault - with urine diversion	10.5	7.3	0.5	7.7
Single/double vault - without urine diversion	7.9	12.9	4.3	11.3
No facility - open field, bush	0.5	13.3	80.7	13.6
Other	0.4	4.4	4.3	3.5

ALCS 2016- 2017

3.2.5- Household living conditions

3.2.5.1- Type of habitation

Type of habitation was also a risk factor for under-five diarrhea. An analysis of cohort studies in children 0-36 months in Brazil in 2008; demonstrated that an excess risk of 6% in the population was attributable to the poor habitation (shacks versus houses/apartments); as well as the prevalence of diarrhea was 1.29 times higher in shacks (substandard apartments or houses made of non-durable materials, and mostly located in urban slums) compared to houses/apartments (PR= 1.29, 95% CI: 1.09-1.53) (12, 38,43).

Another study in Yemen in 2010 also showed that the likelihood of diarrhea in children in households living in shack-type of housing was 3.01 times higher than who lived in permanent housing (OR=3.01, 95% CI: 1.69-4.57) (48). But a study in Ethiopia in 2014; showed no-significant association between the risks of diarrhea in children and roof materials of the households (mud versus corrugated iron) (38,40).

According to a survey in Afghanistan in 2016; 72% of the urban populations lived in slums, approximately 70% of households in the country lived in single-family houses and majority of them were made of mud and almost 15% made of fired bricks and concrete (mostly in urban areas) (12). According to another survey in 2018; almost 89.9% of rural houses and 55.6% of the urban houses had mud made roofs (4).

3.2.5.2- Quality of painting (In/ out)

No specific study showed the direct relation of home painting and diarrhea morbidity but a study in Iraq in 2012 showed that the most attractive colors for house flies were; the black and green and the least was white color (p=0.05) (59). However a multivariate analysis of a study in Ghana in 2005; showed the strong significant association between the presence of houseflies and the high incidence of diarrhea in children (P=0.002, 95% CI) (43).

According to a survey in 2016 in Afghanistan; almost 66.6% of home walls and 71.5% of the roofs were made of mud and wood; thus the muddy color might also attract more house flies (12).

3.2.5.3- Quality of Ground

Quality of floor was also a risk factor for under-five diarrhea. A study from Eritrea in 2001(adjusted for socio-economical status) showed that the prevalence of diarrhea was 30% higher in children living in households with earth-floors compared to non-earth floors (p=0.05) (60). Similarly some studies from Kenya, Tanzania and Bangladesh also showed that soil floors were difficult to clean and usually contaminated by varieties of diarrheagenic agents (bacteria and parasites eggs or ova); moreover geophagia (habit of eating soil) was common among children aged 6-12 months (34%-50% respectively); which contributed to occurrence of diarrhea in children (61,62). But analysis of two cohort studies in Brazil in 2008 showed a no-significant association between unpaved floor and diarrhea prevalence (PR=1.03, 95% CI: 0.84-1.27) and attributable risk of diarrhea in the population was 0% (38).

3.2.5.4- Flooding of habitation during rain

The vulnerability of houses to flooding during rain was also a risk factor for diarrhea in children. A study in Brazil in 2008; showed that the prevalence of diarrhea in children in households prone to flooding during rain was 1.49 times higher than those with no-flooding (PR= 1.49, 95% CI: 1.34- 1.65), as well as 5% excess risk of diarrhea in children in the population, was attributable to household flooding (38). Comparable results also came from multivariate analysis of a study in Yemen in 2010; which showed that the likelihood of diarrhea in children in households experienced sometimes- flooding was 1.99 times higher than those never flooded (OR=1.99, 95% CI: 1.63-2.33) (48).

In Afghanistan; rainfall season was from December – May but heavy rainfall occurred from February to April (63). According to several reports and articles from "flood list" for Afghanistan; showed that every year flash flooding occurs in more than 20 provinces with lots of casualties and deaths (64). Heavy rain could contaminate water sources and floors with human excreta as the result of absence of sewers and waste drainage systems, and breeding of houseflies could contribute to high diarrheal morbidities. Socio-economical status of the households was a major factor for having proper housing with drainage system (5, 12).

3.2.5.5- Presence of toilet

Availability of toilet in the household was also a very important factor for diarrheal diseases in under-five children. Several studies showed a significant positive association between absence of toilets and high incidence and prevalence of diarrheal diseases in children (see section:3.2.4). Furthermore a study from Senegal in 2014 revealed that children of households, who shared toilet facilities were 1.69 times more likely to develop diarrhea compared who had at least one toilet in the household (AOR= 1.69, 95% CI: 1.11-2.56) (45).

A survey in Afghanistan in 2015 showed; the prevalence of diarrhea was slightly higher in those children, who used shared toilet facility compared to those who owned a toilet (31% versus 28% respectively) (5). Another survey in 2016 showed that only 41.4% of the households had basic sanitation facilities at the national level (see section: 3.2.4-Sanitation) (12).

3.2.5.6- Separate kitchen

Existence of separate kitchen in the household was also a risk factor for diarrhea in children. A study in Brazil in 2002 showed that diarrhea risk in children of households who didn't have a separate kitchen was 1.12 times higher than those who had a separate kitchen (R=1.12, 95% CI: 1.02-1.41) (65). A multivariate analysis of another study in Brazil in 2008 also showed a significant positive association between absence of separate kitchen in the household and increased risk of diarrhea in children (AOR=1.44, 95% CI: 1.22-1.70) (49).

No any of the 3 demographic and health and living condition surveys since 2015 showed specific information regarding separate kitchen in Afghanistan (4,5,12), but a cluster survey in 2011 showed that 73% of the urban and 66% of the rural households used a separate room as a kitchen (3).

3.2.5.7- Number of children less than 5yrs in the household

The high number of under-five children in the household was not a risk factor for under-five diarrhea. A study in Ethiopia in 2017 showed that; those children who lived in families who had 2 or more under-five children were 1.5 times more likely to develop diarrhea than those who had only one under-five child (Crude OR= 1.54, 95% CI: 1.04-2.26) (40). Another study conducted in Yemen in 2010 also showed no association between 2 or more under-five children in the household and the increased risk of diarrhea in children (AOR=1.13, 95% CI: 1.00-1.37) (48).

Conversely, a study in Senegal in 2014 showed that< 2 number of under-five children in the households had significant association with the increased risk of diarrheal diseases in children (AOR=2.86, 95% CI:1.7-4.8, P=<0.001) (45).

According to a survey in Afghanistan in 2016; the average size of a household was 7.7 persons and 17 percent of the households constituted by under-five children in the country so almost 1.3 under-five children per household (12).

3.2.5.8- Garbage and excreta disposal

Frequency of garbage disposal and place of garbage collection were important determinants of diarrhea in children. A multivariate analysis of a study in Yemen in 2010 showed that those households who collected garbage daily or every 2nd day; their children were 2.5 times less likely to develop diarrhea compared to others (AOR= 2.51, 95% CI: 2.09-2.99), furthermore children of those households who had garbage dump nearby houses were 2 times more likely to develop diarrhea compared to those who did not have garbage nearby house (AOR=2.04, 95%CI=1.73-2.58) (48).

Comparable results also came from another study in Senegal in 2014 which showed that the risk of diarrhea, in children of households who stored solid wastes in open bags was 1.75 times higher than those who collected properly (p=0.046) (45). Moreover a study from Ethiopia in 2016 showed significant association between faeces (excreta) present around the house compound (children's excreta not properly disposed) and increased prevalence of diarrhea in children (AOR=2.09, 95% CI: 1.24-3.54) (66).

A survey in Afghanistan in 2015 showed that average 15% of under-five children's stool was thrown to garbage as solid waste and average 45% under-five children's excreta disposed of safely (5). Garbage generation in total, was higher because of urbanization in major cities and a study in Kabul in 2012 showed that garbage generation rate was 0.31-0.34 Kg/capita/day much lower than developed countries (average 2kg/capita/day) (67).

3.3- Nutrition

3.3.1- Birth weight

Birth weight was not an important risk factor for under-five diarrhea. A study in Nepal in 2010 showed that the prevalence of diarrhea was 1.68 times higher in children whom birth weights were less than normal (less than 2500 grams) compared to those with normal birth weights (Crude OR=1.68, 95%CI: 0.7-4.03, p=0.24) (51). But, analysis of two cohort studies in Brazil in 2008 showed that a 5% excess risk of diarrhea in children in the population was attributable to birth weights <2500 grams (RR=1.37, 95% CI: 1.24-1.53) (38). The different result came from a univariate analysis of a longitudinal study in Brazil in 2006; which showed that birth weight <2500 gram had protective effect against diarrhea in children (R=0.79, 95% CI: 0.63-0.98) (65).

3.3.2- Feeding, breastfeeding and it's duration

A study in Gaza-strip in 2014 showed a significant positive association between exclusive breastfeeding and low prevalence of diarrhea in children compared to those who did not breastfed (37% versus 63.3% respectively; p= ≤0.001) (50). Starting up complementary feeding after 6 months of age, bottle feeding, unhygienic environment, starting crawling and walking and ingestion of contaminated foods by themselves made them more susceptible to diarrhea after six months of age. Because of less chance of contamination

by the environment and having maternally acquired immunity exclusive breastfeeding protected children from diarrheal diseases (5, 50).

A study in Brazil in 2016 showed that children of those mothers who knew that breastfeeding protects their children against diarrhea were significantly associated with low risk of diarrhea in their children (p=0.028) (44). Similarly a multivariate analysis of a study in Yemen in 2010 showed; children who breastfed were 1.82 times less likely to develop diarrhea compared to those who fed by other milk (AOR=1.82, 95%CI: 1.58-2.26), moreover the risk of developing diarrhea in children who did not breastfeed (fed by other foods) was 2.65 times higher compared to those who breastfed (AOR=2.65, 95% CI: 2.42-2.89) (48).

Duration of breastfeeding also had an association with diarrhea prevalence; a study from Ethiopia in 2009 revealed that diarrhea prevalence was 2.71 times higher in children of those mothers who breastfed their children for < 1year compared to those who breastfed their children for ≥ 2 years (AOR=2.71, 95%CI: 1.02-7.25) (68).

According to a survey in Afghanistan in 2018; almost 98.6 percent of Afghan children ever-breastfed in their life and approximately 57.5% were exclusively breastfed between 0-5 months of age; furthermore, almost 50% of under-nine months infants received complementary feeding (liquid, other milk, mushy foods) (4). Another survey in 2015 showed that almost 80% children up to 19 months of age and 50% up to 2 years received breast milk with complementary foods (5).

3.3.3- Anthropometric Measures

Nutritional status of the child was also a very important factor for diarrhea in under-five children which could be assessed by weight, height, mid-upper arm circumference (MUAC) weight for height z- score (WHZ), length for age z-score (LAZ)or height for age z-score (HAZ) and weight for age z-score (WAZ) (19, 69). There were two major types of under nutrition as wasting and stunting; According to analysis of 8 cohort studies from developing countries wasting (acute malnutrition as WAZ or WHZ or WLZ < -2 SD (standard deviation)) usually preceded stunting (chronic malnutrition as LAZ< -2 SD) (69).

According to a study in Egypt in 2001; significant positive association found between WAZ < -2SD (wasting) and increased incidence of diarrhea in children (RR=1.7, p= < 0.01) as well as diarrhea itself was significantly associated with the subsequent attack of diarrhea (RR=2.1, p= <0.001); ultimately increased risk of under-nutrition (a vicious cycle) (70). Similarly a study in Bangladesh in 2014 showed that geophagia was associated with increased risk of diarrhea and its recurrence, as well as children who had geophagia were 2.27 times more likely to develop stunting (HAZ< -2 SD) compared to those who did not have geophagia (fully adjusted OR=2.27, 95%CI: 1.14-4.51) (62).

Comparable results also came from another study conducted in Brazil in 2008; which showed that 5% excess risk of diarrhea in the population was attributable to sub-nutrition (HAZ < -1 SD) (PR=1.28, 95%CI: 1.17-1.4, adjusted AR=22, AR Total=5%) (38).

According to a survey in Afghanistan in 2018; at 95% confidence level; almost 36.6% of all under-five children were stunted and 17.3% were severely stunted (HAZ < -3 SD) as well as 5% were wasted and 1.5% were severely wasted (WHZ < -3 SD) which were major factors for under-five diarrhea in the country (4).

3.4- Hygiene Behaviour of the mother or caretaker

Hygiene behaviour of the mother was also a very important determinant of diarrhea in under-five children. A report from systematic reviews by WHO in 2007; showed that only hygiene interventions could reduce diarrhea morbidities and mortalities with a median of 33% (56). A systematic review and meta-analysis from LMICs in 2003 showed that risk of diarrheal diseases was 1.88 times higher in those households who did not wash their hands compared to those who washed (RR=1.88, 95%CI: 1.31-2.68); moreover hand washing could reduce risk of diarrhea by 47%, and pool of high-quality studies who also mentioned "soap" could reduce diarrhea risk by 42%-44% (71).

Furthermore, a study from Ethiopia in 2009 showed that diarrhea risk was higher in children of those mothers or caretakers who lacked the knowledge regarding "flies could transmit diarrheal diseases" compared to those who did know (OR=2.12, 95% CI: 1.42-3.17); as that could change their behaviour (68). Diarrhea prevalence was also high in children of those mothers; who did not properly dispose their children faeces or not collected garbage regularly (see section:3.2.5.8).

A survey in Afghanistan in 2015 showed that less than 36% of the households had ideal hand washing agents and another 28% had water only (total 64%); more than 28% did not have soap, water or any other cleaning agent; urban households were 3 times and richest wealth quintile were almost 7 times more likely to have proper place for hand washing, soap and water compared to rural households and poorest respectively (5).

3.5- Age and Gender

3.5.1-Age

A survey in Pakistan in 2017; showed that diarrhea prevalence in children less than 6 months old was 21% as compared to 31% in those aged 6-11 months (73). A systematic review from 139 LMICs in under-five children in 2010 showed that diarrhea incidence was higher among children aged 6-11 months as 4.5 episodes/child/year (because of starting up complementary feeding and ingestion of stuff from the floor; while crawling) to be compared with 2.3 episodes/child/year in children 24-59 months old (72). Poor hygiene, low mothers' education level and contamination from the environment were contributing factors in these age groups.

A survey in Afghanistan in 2015 showed; that diarrhea prevalence was 38% in children aged 12-23 months as compared to overall 29% in under-five children and a rapid increase in diarrhea prevalence has also been observed after 6 months of age as the result of introduction of complementary feeding (5, 72).

3.5.2-Gender

Diarrhea prevalence was slightly higher in under-five boys as 29.5% in Afghanistan in 2015; compared to 27.8% in girls (5).

A study in Brazil in 2008; showed that the risk of diarrhea among boys was higher with prolonged duration as they were more exposed to the environmental factors (as they were more allowed to play outside the house without any observation) than girls (COR=2.48, 95%CI:1.01-6.12) (74).

A cohort study in under-five children in Bangladesh in the year 2000 showed; as the result of health-seeking delay, the risk of diarrheal deaths among girls was 2 times higher than boys (P=0.003), as well as suffered more from severe infections compared to their male counterparts (culturally, people do not like girls; as they didn't want to spend more money for girls compared to boys) (90).

Comparable results also came from another study in India in 2002 which showed that boys were 4.9 times more likely to be taken earlier to health facility than girls (95% CI: 1.8-11.9), furthermore parents were 4.2 times more likely to spend money on their boys illnesses and foods than girls (95% CI: 1.6- 10.9) (91). Thus Gender discrimination, not only caused high mortality in girls but made them vulnerable to early marriage, low education level and less employment which all contributed to high diarrheal morbidities and mortalities in under-five children (see section: 3.1.2).

Chapter 4

Policies, Strategies and WASH Interventions

This chapter examines the third objective of this study. Policies and strategies regarding controlling diarrheal diseases in under-five children including WASH interventions in Afghanistan are presented below:

4.1- WASH Policies and Interventions in Afghanistan

Access to clean drinking water, proper Sanitation and Hygiene promotion (WASH) was crucial for prevention of varieties of infectious diseases; these interventions have been provided to large populations to contain transmission of infections (75).

Poor WASH facilities were strongly associated with diarrheal diseases (see sections 3.2 and 3.4), however; WASH interventions were fundamental for the prevention of diarrheal diseases, that's why Afghan National Development Strategy (ANDS) 2008- 2013 paid more attention to these interventions especially in rural areas (14, 75).

WASH interventions; more specifically water intervention had been started at the beginning of the 1990s by Danish Committee for Aid to Afghan Refugees (DACAAR) especially for refugees, internally displaced people, repatriates, in rural areas, and in crisis conditions with establishment of > 50,000 water points across 29 provinces (76). Furthermore World Bank also supported "urban water sector project" in 2006 but no longer active anymore in this field (77, 78).

Though WASH projects have been implemented since 2001 and mostly supported by USAID; still Afghanistan ranked 9th in terms of WASH "need" in 2016 (77).

In 2004; government adopted population targets of 62% for access to improved water and 66% access to improved sanitation, to achieve the MDG goal. Government witnessed considerable achievements since 1990; especially after 2004; as in 2015 access to clean drinking water and improved sanitation was 63% and 39% respectively, but Afghanistan was still far behind the sanitation target of 66%, but it was expected to be achieved by 2020 (77). It is worth mention that variation existed among the regions as access to improved water in Central Highland was 30% but 80% in South-Eastern region (77).

National Rural WASH Policy- 2010 has been adopted by the Ministry of Rural Rehabilitation and Development (MRRD) in line with ANDS 2008- 2013 for achieving the MDG targets for improved water, proper sanitation and hygiene promotion in rural Afghanistan(to halve the proportion of people lacking sustainable access to proper sanitation and improved drinking water by 2020) (77, 79). Sector institutions strengthening and capacity building, proper governance, ensuring transparency, creating WASH database for the whole country, promoting partnerships with civil societies and communities and strategic investment were included in this policy.

Rural water supply, sanitation, and irrigation program (Ru-WatSIP) had the responsibility to implement the policy which later; in 2017, expanded to Citizen's Charter National Priority Program whom goal was to increase access to safe water to 76% and 36% extra access to sanitation at the national level. The Ministry of Finance was the primary major stakeholder for Ru-WatSIP as well as supported by United Nations International Children's Emergency Fund (UNICEF) and USAID (77, 79).

Afghanistan is meeting its WASH targets in alignment with the USAID Potable and Productive Water Project (PPWP) and Global Water Strategy (GWS). Seven WASH activities have been supported by PPWP (see Table-4); which were expected to provide access to improved water supply for additional >700,000 Afghans and improved sanitation for additional > 1 million Afghans by 2021 (77).

Table 4: Main WASH activities and Mechanisms by PPWP in Afghanistan in 2016 (77).

Activity	Duration	Implementation Approach	Status
Rural Water, Sanitation, and Hygiene	2016 – 2020	Public International Organization Agreement	Implemented by UNICEF
Initiative for Hygiene, Sanitation and Nutrition (IHSAN)	2016 – 2021	Contract	Implemented by FHI 360
Kabul Urban Water Supply	2017 – 2019	Agreement on delegated cooperation	Implemented by German Development Bank KfW
Kabul Managed Aquifer Recharge pilot	2016 – 2018	Public International Organization Agreement	Implemented by the Asian Development Bank
Emergency WASH	2014 – 2019	Grants	Three grants being implemented. Additional round in procurement.
New			
Leveraging Urban Water Supply and Sanitation Initiative	2017 – 2021	TBD	In procurement
Afghanistan Jobs Creation Program	2017 – 2020	Grants/cooperative agreements	In procurement

Water and Development Country Plan for Afghanistan- 2016

National infrastructure plan 2017-2020 did not mention anything about "Urban WASH" policy or any other investment programs regarding water supply and sanitation for the urban population but German Development Bank (KfW) was the major donor for urban-WASH as well as Greek and French governments and USAID were supporting donors (77, 80).

National Rural- WASH policy 2010 has been revised and replaced with Rural- WASH 2016-2020 to meet the ambitions of SDG- 6 by 2030; as "to ensure availability and sustainable

management of water and sanitation for all" as well as this policy supposed to be revised again in 2020 to be in line with SDG 6 (81).

UNICEF was an active participant in Rural-WASH especially in hard to reach areas, school-WASH, hygiene promotion, and education; furthermore, UNICEF received significant funds from USAID, Japan, Republic of Korea and Finland for the above-mentioned projects too. Moreover in collaboration with MOPH and WHO they rehabilitated "WASH" in health centres as well as coordinated "WASH" in emergency clusters, and almost 300,000 new people got access to clean water in 2017 (77,82).

In alignment with the National Hygiene Promotion Strategy 2017- 2020; UNICEF constantly worked with the Ministry of Education to support School- WASH (establishment of washrooms in toilets, hygiene promotion education, menstrual hygiene facilities, and clean water supply)which had tremendous impact on the health of schoolgirls and overall population as that encouraged them to stay at schools, increased attendance and they could share gained information regarding proper hygiene practices with their families too (82, 83).

National Hygiene Promotion Strategy (NHPS) 2017-2020 was also compatible with result#3 of National Health Strategy (NHS) 2016-2020 as "reduced preventable deaths, illness, and disability through the provision of cost-effective, high impact evidence-based public health interventions" (16, 83). Key messages of NHPS are briefly presented in Table-5 (83).

Table 5: Components of key messages for hygiene promotion, in Afghanistan (83).

No	Area	Components of key messages
1	Water	Improved water sources, Water- storage container material, importance of cover and tap, regular washing of the water container with soap and water, hygienic consuming from container and treating of unimproved water by boiling, chlorination, filtering and exposing to sunlight.
2	Sanitation	Distance of the toilet from the water sources, Use of latrine at home, Proper disposal of human feces, Risks of open defecation and its avoidance, Proper disposal of garbage, cleanliness of home environment
3	Hygiene	-Washing hands with water & soap: before and after eating, before preparing/ handling foods, before breast feeding, after cleaning of babies excreta, before and after touching patients, before and after delivering a baby and dressing wounds. Importance of regular baths, Regular clipping of nails or keeping them clean, Brushing and floss of teeth, wearing shoes/ slippers while walking outside, keeping clean and functional of school/ health centers WASH facilities.
4	Food Hygiene	Washing hands with water & soap before and after eating, before preparing/ handling foods, before breast feeding, Protecting foods from flies, other insects and rats etc by keeping it covered or put it in cabinets safely and in cool places if they were fresh, washing vegetables and fruits before eating, washing kitchen utensils before and after each food preparation with soap and hot water,
5	Menstrual Hygiene	-menstruation is a clean and normal process (No shame, not unclean process) -changing pads and napkins frequently, regular washing and bathing is helpful, sanitary clothes that reused should be washed properly and dried in sunlight, used napkins or towels should be wrapped and disposed in trash bins.

NHPS 2017-2020

In Rural- Afghanistan; improved sanitation coverage increased from 21% to 38.8% from 2000 to 2016, while clean drinking water supply increased from 24% to 47% from 2000-2015 (but in 2016 only 25.1% had access to safely managed drinking water, see section-3.2.1.3.1) (12, 81).

4.2- Rotavirus Vaccination

Rotavirus was responsible for 72.2 % cases of diarrheal diseases in under-five children in Afghanistan (see section 2.1).

"Communicable diseases policy statement" of National Health Policy (NHP) 2015- 2020 endorsed that rotavirus vaccination should be included in routine immunization and provided free; through both private and public health facilities to all, who intended for (84).

Routine immunization was provided by Expanded Program on Immunization (EPI)-Afghanistan and mostly supported by Global Alliance for Vaccines and Immunization (GAVI).

Introduction of rotavirus vaccination; in routine immunization in Afghanistan approved and supported by GAVI in 2017 (85, 86); Moreover according to Afghan Immunization Plan (AIP) rotavirus immunization coverage started with 10% in 2017 and expected to increase the coverage to 90% in 2019 (85). Adoption of this policy and strategies expected to significantly reduce diarrheal morbidities and mortalities in under-five children in Afghanistan in future (85).

4.3- Children's Nutrition

In order to improve the overall health of the child and increase their immunity against various infectious diseases, nutritional interventions and education regarding feeding were crucial to treat and prevent malnutrition and interrupt malnutrition-diarrhea vicious cycle (see section 3.3).

National Health Policy 2015-2020 mentioned (84, 87); a multi-sectoral strong commitment to:

- Reduce poverty.
- Management and nutritional supplementations of children with moderate to severe malnutrition (acute and chronic under-nutrition).
- Behavioural change to improve nutritional practices as well as infant feeding and caring by community approaches.
- To address micronutrient deficiencies (high priority; iron, vit A, vit D, zinc, calcium& iodine).
- Educational programs on food fortification and food hygiene (see Table-5).
- Adolescent nutritional interventions (micro nutrient supplementation) to interrupt intergeneration under- nutrition cycle.

On-time diagnosis and management of acute diarrheal diseases at all health levels through Integrated Management of Neonatal and Childhood Illnesses (IMNCI) strategy; would also improve appetite, reduce chronic diarrhea and under nutrition (87, 88).

National Public Nutrition Policy and Strategy (NPNPS) 2009-2013 focused on eight nutritional strategic priorities which targeted under-five children and pregnant women and mothers in alignment with MOPH strategic plan 2011-2015 (89).

NPNPS 2009-2013 revised and replaced with NPNPS 2015-2020 to further meet the nutritional requirements of the population, especially under-five children and pregnant women (More specifically; evidence-based interventions for prevention and management of under nutrition and Breaking the infection- malnutrition cycle by integrated approach) (87).

Thirteen evidence-based cost-effective planned nutritional interventions in the first 1000 days of life (from conception to 24 months after birth) are listed in Table-6 (87).

Table 6: Categories of evidence-based direct interventions and their sub-components adopted by Scaling Up Nutrition (SUN) movement to prevent and treat malnutrition in children < 24-month-old (87).

Categories			
I	II	III	IV
Promoting good nutritional practices	Provision of vitamins and minerals for pregnant women and young children	Provision of Fortified Foods	Therapeutic Feeding for Malnourished Children
1- Timely initiation and exclusive Breast Feeding until 6 months of age 2- Provision of vitamins and mineral-rich complementary foods for infants after 6 months of age 3- Appropriate hygiene practices including hand washing, by caregivers of infants and toddlers	4- Vitamin A supplements for children 5- Zinc supplements for treatment of diarrhea 6- Use of multi-micronutrient powders (as "in home" food fortificants) 7- Deworming drugs for children (to improve nutrient absorption) 8- Iron, Folic Acid supplements for pregnant women to prevent and treat anemia 9- Iodized oil capsules, where iodized salt is not available	10- Iodized Salt 11- Iron fortification of staple foods	12- Prevention or Treatment of moderate acute malnutrition 13- Treatment of severe acute malnutrition (with ready to use therapeutic foods)

NPNPS 2015-2020

4.4- Environmental Health

Afghanistan Environmental Health Policy (AEHP) 2010; focus on urban environment protection as garbage collection, collection, and disposal of industrial waste, toxic waste as well as healthcare waste and expansion of urban development programs including sewage systems (75).

Urban Development Strategy of ANDS 2008-2013; also focussed on municipality capacity strengthening as well as phased regularization of informal settlement (restructuring of improper settlements and provision of infrastructure) and solid waste management (14).

In 2018; despite policies and strategies mentioned above, municipalities lacked the capacity to deal with solid waste in general; as in Kabul (the capital), almost 70% of total solid waste was accumulated in backyards, roadsides, open places, drains and rivers (92). Almost 1.5% of the population had access to closed sewer system in Afghanistan in 2016 (12).

Chapter 5

Discussion, Conclusion, and Recommendations

This chapter presents the fourth objective of this study as providing recommendations to policymakers and relevant stakeholders; as well as discussions and conclusion as follows:

5.1- Discussion

Decades of war in Afghanistan, resulted in poor economy and dependency to foreign aids, insecurity, political instabilities, fragile governance, fewer opportunities for higher education, fewer opportunities for employment and the resultant poor household economy.

In order of importance, this study showed that; poor household economy, poor access to WASH facilities, poor access to proper nutrition and optimal living conditions were the most important factors for diarrheal diseases in under-five children in Afghanistan. Poor nutrition could cause malnutrition. Malnourished children were more susceptible to varieties of infectious diseases including diarrhea. Furthermore, infectious diseases led to poor nutrition and malnutrition (a vicious cycle). Geophagia was also significantly associated with recurrent diarrhea and stunting.

Current policies and strategies in Afghanistan; regarding the provision of WASH facilities in rural areas, nutritional interventions for pregnant women and young children as well as introduction of rotavirus vaccination in routine immunization in 2017; were optimistic to meet the needs of the poor and vulnerable. These interventions expected to considerably reduce under-five diarrheal morbidities and mortalities in near future. In my knowledge; PN policies and strategies, as well as IMNCI strategies, will help to tackle geophagia too.

Fortunately, Breastfeeding with longer duration had a protective significant association with diarrhea, which was a common practice in Afghanistan.

As from my own experience; the majority of the poor people tended to live in cheaper accommodations in slums or remote areas; where basic infrastructure facilities were not available, and improper garbage dumps were near the residential areas.

Most of the people did not have enough money even for foods and medicines, so difficult to buy cleaning agents as well. Though Urban Development Strategy of ANDS has been implemented along with "phased regularization of informal settlement", but was ineffective till 2018 in Afghanistan.

This review also showed that; Garbage dumps nearby house, infrequent garbage collection, as well as disposal of infant's excreta into the garbage was significantly associated with increased diarrheal morbidities in children and were common problems in Afghanistan. Municipalities did not have the capacity for garbage collection even in major cities and there were no programs for rural areas. Though ANDS 2008-2013 and AEHP 2010 focussed on waste management and sewage system through municipality support strategies but did not

help till 2018. As of my own experience; recently some private companies started to collect garbage from houses in some cities regularly for monthly fee but not everyone could pay nor was the coverage optimal.

This review further argues that; the poor economy could not guarantee higher levels of education, employment and on-time access to quality health care; that was necessary for productive general health and protection against diarrheal morbidities and mortalities in children. Fortunately, National Health policies, BPHS, EPHS, and IMNCI strategies support and provide health care free of cost but still, people had to pay for medicines and indirect costs; that might have prevented families to seek health when needed.

This review also showed that Cultural and gender issues indirectly contributed to high diarrheal morbidities and mortalities in under-five children in Afghanistan; as females had less chance to be educated, to have a job and to marry by their own choice at an older age; that all had a significant association with high diarrheal morbidities in children. Furthermore, data from LMICs showed that people willed to spend more money in real-time for their boys' health and nutrition than girls, as the result; higher mortalities and severe infections observed in girls compared to boys.

As of my personal experience; people in Afghanistan preferred boys and spent more money on their foods, clothing and health care than girls, but still, sufficient amount spent on girls too. However, diarrhea prevalence was slightly higher in boys than girls in Afghanistan.

As of my own experience, majorities of the rural population believed that; the girls should only attend basic religious schools (*Madrasas*), do their home chores and no need for girls to attend schools; as well as women employment was a stigma. Furthermore failure in decision making by mothers; to take their children to a health facility alone; also contributed to the severity of the disease and high mortalities in children. Though some religious people were against any type of vaccination; Still, vaccination coverage in the country was satisfactory.

This study found that Houseflies had a key role in the transmission of diarrheal causative agents as well as, they had high affinity to dark colour walls, especially to black and green; which could attract more flies around the house. Majority of people lived in muddy houses (dark coloured) both in urban and rural areas in Afghanistan. As of my own experience; excess numbers of houseflies were present in most provinces (from residential areas to shops, offices and even hospitals; over the year, except in very cold and very hot weather). There were no specific government commitments or strategies to cope with the houseflies in Afghanistan.

Higher inequalities have been observed within the urban, rural and Kuchi populations as well as the richest and poorest. These inequalities could be attributed to poverty, internal conflicts, insecurity, fragile governance, political instability, hard to reach and mountainous geographical locations and less attention to Kuchi population. In one hand they might prevent implementation of developmental projects; on the other hand, rapid population growth and urbanization required recurrent "needs assessment", expansion of developmental projects and further funding. Rough terrain, harsh climate and low investment in infrastructure because of decades of wars were some other barriers.

Reflection on the Conceptual Framework

The applied framework was very useful for examining almost all of the relevant factors and objectives of this study but only a few parts as "age and gender" issues were related to socio-cultural factors; that were also very important determinants of under-five diarrhea but out of the scope of this study. For next researches, it is better to, also look for cultural factors and add them as a separate block to the framework.

Strengths and limitations of the study

Quality assessment of studies was out of the scope of this review but Majority of the studies selected; have looked for confounders and confidence levels, moreover; some of them were systematic reviews with meta-analysis.

Limited studies found for Afghanistan. However, it was not a systematic review and different study types done in different settings; conflicting results came for some of the factors as follows:

Multivariate analysis of only one study in Nepal showed no association between unhygienic blocked drainage around the house and increased risks of diarrhea; however, this study was a cross-sectional study and was done in winter. In my opinion, in winter; bacterial growth is slow and no flies to transmit the diarrheagenic agents, so less reliable and needs further researches.

Contradicting results came from several studies regarding the association between floor type and diarrhea. Analysis of two cohort studies in Brazil showed no- association between unpaved floor and diarrhea but several studies from Asia and Africa showed a significant association, and added that earth floors were difficult to clean and mostly contaminated by diarrheagenic agents. In my point of view, the most possible reason for this difference could be culture of childcare pattern; children usually tend to spell some foodstuffs on the ground and retake them or ingest anything from the floor; which make them vulnerable to be infected and diseased.

Though; flash flooding was common in all over Afghanistan but no data available for household flooding during the rainy season and its relation to diarrheal diseases. Household flooding could spread human faeces and garbage around the house which facilitate contamination of floors and materials and house flies breeding; especially where there is no proper sanitation and proper places for garbage collection. As less than 2% households in Afghanistan had closed sewer system thus it could be a major factor for under-five diarrhea in rainy seasons.

Conflicting results came for the 'more number of under-five children in the household' and increased risk of diarrhea among children; one study from Ethiopia found positive association but not looked for confounders and multivariate analysis of another study conducted in Yemen showed a weak association. However, multivariate analysis of another

study in Senegal showed a strong association between fewer than 2; under-five children in the house and increased risk of diarrhea in children.

In Afghanistan up to present, no articles or researches found to show an association between diarrheal diseases and cultural factors as well as gender issues.

Conflicting results also came for the association between birth weight <2500 grams and high diarrheal morbidities in under-five children. One study showed a positive association which didn't look for confounders but analysis of an interventional cohort study showed significant positive association. Conversely, univariate analysis of a longitudinal study in Brazil showed birth weight <2500grams had protective effect (negative association).

5.2- Conclusion

In order of importance, this study found that; poor household economy, improper sanitation, improper hygiene practices regarding hand washing with soap and food handling, poor access to clean drinking water in sufficient quantity, mothers' low level of education and unemployment, children's poor nutrition, improper garbage collection and disposal as well as early marriage in girls were the most important factors for diarrhea in under-five children.

This review also showed; More than half of the population in Afghanistan lived below the national poverty line, more than 60% of the population did not have access to basic sanitation, almost one third of the population didn't have access to clean water; soap or any other cleaning agents for hand washing, a small proportion of adult women had more than secondary education, more than 85% women aged 15-49 years were unemployed and more than one third of under-five children were stunted. Overcrowding housing condition was also a major problem nationally, especially in Kuchi population. Furthermore, early marriage in girls was also common; all of them significantly contributed to diarrheal diseases in under-five children in the country.

Majority of the urban population lived in slums as well as in shack-type of housings with poor infrastructure. Though Urban Development strategy of ANDS had been implemented along with "phased regularization of informal settlement", but was ineffective till 2018.

Government of Afghanistan developed, applied and recurrently revised policies and strategies regarding control of diarrheal diseases such as NHP, ANDS, National Rural WASH policies, NHPS, AEHP, the introduction of rotavirus vaccination to routine immunization and NPNPS; showed strong government; commitment for preventing diarrhea; and ending preventable deaths in under-five children.

As rotavirus was the most common cause of diarrhea in under-five children in Afghanistan and the recent introduction of its vaccine in routine immunization, NPNPS as well as revised Rural WASH Policy and strategies were expected to considerably reduce diarrheal morbidities in near future.

Despite all policies and strategies mentioned and improvements over the years; rural Afghanistan was still; far behind the MDG and SDG for sustainable WASH facilities (from latest available data). Afghanistan reached its MDG target for water supply at the national

level but far behind in rural areas, and the access was worse in Kuchi populations. Still, at the national level poor sanitation and improper hygiene practices were major problems and coverage was far behind the MDGs targets. Sanitation coverage was even worse; in nine provinces as <20%. Moreover environmental health policy and strategies were not effective; especially regarding replacement of informal settlements, solid waste management, and sewage systems even in urban areas.

Poor economy, insecurity, fragile governance, political instability, rapid population growth, urbanization, hard to reach and mountainous geographical locations, low investment in infrastructure because of war, harsh climate and rough terrain were some barriers for developmental projects.

5.3- Recommendations

Based on the study results; the following recommendations are proposed to the government of Afghanistan, policymakers, MOPH, MRRD, Ministry of Finance, Ministry of Hajj and Religious Affairs (MHRA), researchers and international partners and donors:

For policies:

1. Government and line ministries should advocate for girls education, expansion of its coverage as well as women empowerment with the help of MHRA; both in education, decision making, marriage, family planning, and employment.

2. National Environment Protection Agency of Afghanistan (NEPA), Ministry of Urban Development and Land (MUDL) and other stakeholders should revise environmental health policy and strategies 2010; especially for waste management and establishment of sewer systems in the country and plan interventions according to priorities feasibility.

3. Special attention should be paid to Kuchi population by helping and providing them infrastructures in two different locations; in winter and summer.

4. The government should revise and develop strategies to create job opportunities for women according to feasibility and cultural norms.

5. Allocation of more funds for medical supplies in BPHS and EPHS programs; that will help to increase access to health care and lessen the fear of high OOP expenditures.

Future research examples:

1. To investigate cultural factors and their association with under-five diarrhea, in Afghanistan.

2. To include some of the factors in next demographic and health survey; such as geophagia in under-five children, houseflies around the house and household flooding during the rainy season and their association with under-five diarrhea, as well as to investigate "proportion of the population who are against women employment".

3. To investigate gender inequalities regarding spending money for nutrition and health-seeking behaviours of parents for their under-five girls and boys in Afghanistan.

4. To investigate, higher than two under-five children in the house and its association with under-five diarrhea in Afghanistan.

References

1- Aluisio AR, Maroof Z, Chandramohan D, Bruce J, Masher MI, Manaseki-Holland S, Ensink JH. Risk factors associated with recurrent diarrhoeal illnesses among children in Kabul, Afghanistan: a prospective cohort study. PLoS One. 2015 Feb 13;10(2):e0116342.
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0116342
Access date: 13/ 03/ 2019

2- Troeger C, Blacker BF, Khalil IA, Rao PC, Cao S, Zimsen SR, Albertson SB, Stanaway JD, Deshpande A, Abebe Z, Alvis-Guzman N. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Infectious Diseases. 2018 Nov 1;18 (11):1211-28.
https://www-sciencedirect-com.vu-nl.idm.oclc.org/science/article/pii/S1473309918303621
Access date: 14/ 03/ 2019

3- United Nations International Children's Emergency Fund (UNICEF). Afghanistan Multiple Indicator Cluster Survey 2010-2011. Kabul: Central Statistics Organisation (CSO); 2012.
http://cso.gov.af/Content/files/AMICS-Jun24-2012-FINAL.pdf
Access date: 14/03/ 2019

4- Royal Tropical Institute. Afghan Health Survey (AHS). 2018.
https://rmncah-moph.gov.af/blog/2019/03/02/ahs-2018/
Access date: 30/05/2019.

5- Ministry of Public Health Afghanistan. Afghanistan Demographic and Health Survey (ADHS) (2015).
http://old.moph.gov.af/Content/Media/Documents/Afghanistan2015-Complete_CDversion_01-31-201717920171314596701458322570.pdf
Access date: 14/03/ 2019

6- Gopalakrishnan R. The geography and politics of Afghanistan. Concept Publishing Company; 1982.
https://books.google.nl/books?hl=en&lr=&id=29bg7g1U6coC&oi=fnd&pg=PR10&dq=afghanistan+geography+and+climate&ots=boSyvL-BIz&sig=-TSS3j7gxvaFPs65ufKZF6nMC0I#v=onepage&q=afghanistan%20geography%20and%20climate&f=false
Access date: 01/ July/2019.

7- Central Statistics organization Afghanistan. Demographic and social statistics.
http://cso.gov.af/en/page/1500/4722/2016-17
Access date: 01/ July/2019.

8- Central Statistics organization Afghanistan. Population 2018.
http://cso.gov.af/Content/files/%D8%B1%DB%8C%D8%A7%D8%B3%D8%AA%20%D8%AF%DB%8C%D9%85%D9%88%DA%AF%D8%B1%D8%A7%D9%81%DB%8C/population/Final%20Population%201397.pdf Access date: 26/ 06/2019.

9- Kelly AT. Rebuilding Afghanistan's Agriculture Sector 2003.
https://www.think-asia.org/bitstream/handle/11540/2577/rebuilding-agriculture-sector-afg.pdf?sequence=1
Access date: 01/ July/2019.

10- The World Bank. data- Afghanistan 2018. Accessed: 25/05/2019
https://data.worldbank.org/country/afghanistan
Access date: 26/ 06/2019.

11- United Nations. United Nations Statistics Division. World Statistics Pocketbook. 2018.
https://unstats.un.org/unsd/publications/pocketbook/files/world-stats-pocketbook-2018.pdf
Access date: 01/ July/2019.

12- Afghanistan Living condition survey 2016- 17 (ALCS). Central Statistic Organization, Afghanistan.
http://cso.gov.af/en/page/1500/1494/nrav-report
Access date: 01/ July/2019.

13- Ministry of Foreign affairs- Islamic Republic of Afghanistan.
https://www.mfa.gov.af/constitution/preamble.html
Access date: 01/ July/2019.

14- United Nations Development Program (UNDP). Afghanistan National Development Strategy 2008- 2013.
https://www.undp.org/content/dam/afghanistan/docs/ANDS_Full_Eng.pdf
Access date: 02/ July/2019

15- Nojumi N. The rise of the Taliban in Afghanistan: Mass mobilization, civil war, and the future of the region. Springer; 2016 Apr 30.
https://books.google.nl/books?hl=en&lr=&id=h18YDAAAQBAJ&oi=fnd&pg=PP1&dq=political+environment+in+afghanistan&ots=Oyq4tNlG4L&sig=VGQo1WwfZhF9XaAYRJWl-popaos#v=onepage&q=isis&f=false
Access date: 02/ July/2019.

16- National Health Strategy 2016–2020, Ministry of Public Health Afghanistan. Sustaining progress and building for tomorrow and beyond.
http://www.nationalplanningcycles.org/sites/default/files/planning_cycle_repository/afghanistan/afghanistan_mophstrategy2016-2020_final09september20161112016145089505533325325.pdf
Access date: 02/ July/2019.

17- Ministry of Public Health- Afghanistan. Revenue Generation strategic Frame Work for Health Sector 2018.
https://moph.gov.af/en/strategies
Accessed: 25/05/2019

18- Jāhāna S. Human development report 2016. Human development for everyone. United Nations Publications. 2016.
http://www.hdr.undp.org/sites/default/files/2016_human_development_report.pdf

Access date: 02/ July/2019.

19- Amiri W. Early Warning System for Priority Infectious Diseases in Afghanistan. Analysis of Nine Years Data, 2007-2015. Ghazanfar Medical Journal (GMJ). 2016 Jun;1(007):75.
http://old.moph.gov.af/Content/Media/Documents/GhazanfarMedicalJournalVol.149201610321694355332532 5.pdf
Access date: 29/ 06/ 2019.

20- MOPH- Afghanistan. A Basic Package of Health Services for Afghanistan. 2005/1384.
http://apps.who.int/medicinedocs/documents/s21746en/s21746en.pdf
Access date: 29/ 06/ 2019.

21- Ministry of Public Health. Afghanistan national health accounts with subaccounts for reproductive health 2011–2012.
https://www.healthpolicyproject.com/pubs/262_AfghanistanNHAReportFINAL.pdf
Access date: 29/ 06/ 2019

22- GBD Diarrhoeal Diseases Collaborators. Estimates of global, regional, and national morbidity, mortality, and aetiologies of diarrhoeal diseases: a systematic analysis for the global burden of disease study 2015. *The lancet infectious diseases*. 2017;17(9):909-948. doi:10.1016/S1473-3099(17)30276-1
doi: [10.1016/S1473-3099(17)30276-1]PMCID: PMC5589208
Access date: 14/ 03/ 2019

23- UNICEF. Committing to Child Survival. Progress Report. 2012.

https://www.unicef.org/publications/files/APR_Progress_Report_2012_11Sept2012.pdf
Access date: 14/03/ 2019

24- World Health Organization (WPRO 2018). Acute watery diarrhoea.
http://www.wpro.who.int/laos/topics/diarrhoea/en/
Access date: 13/ 03/ 2019

25- Ministry of Public Health Afghanistan. Weekly Epidemiological Report–50th (DEWS-Plus). 11-17 Dec/ 2016.

http://moph.gov.af/en/documents/category/dews-plus-2016
Access date: November 2018.

26- World Health Organization. Cholera in Afghanistan- Report. 2001 Jul.

http://www.who.int/csr/don/2001_07_26b/en/
Access date: 15/03/ 2019

27- Guerrant RL, Oriá RB, Moore SR, Oriá MO, Lima AA. Malnutrition as an enteric infectious disease with long-term effects on child development. Nutrition reviews. 2008 Sep 1;66 (9):487-505.
https://academic.oup.com/nutritionreviews/article-abstract/66/9/487/1854813
Access date: 15/03/ 2019

28- Rheingans R, Kukla M, Adegbola RA, Saha D, Omore R, Breiman RF, Sow SO, Onwuchekwa U, Nasrin D, Farag TH, Kotloff KL. Exploring household economic impacts of childhood diarrhoeal illnesses in 3 African settings. Clinical infectious diseases. 2012 Dec 15;55(suppl_4):S317-26.
https://academic.oup.com/cid/article/55/suppl_4/S317/326768
Access date: 15/03/ 2019.

29- National Risk and Vulnerability Assessment (NRVA). Afghanistan Living Condition Survey 2011- 2012.
http://www.ilo.org/surveydata/index.php/catalog/1644/study-description
Access date: 15/03/ 2019.

30- Elyan D, Wasfy M, El Mohammady H, Hassan K, Monestersky J, Noormal B, Oyofo B. Non-bacterial etiologies of diarrhoeal diseases in Afghanistan. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2014 Jun 18;108 (8):461-5.
https://academic.oup.com/trstmh/article/108/8/461/2765204
Access date: 14/03/ 2019.

31- Trends of vaccine-preventable diseases in Afghanistan from the Disease Early Warning System, 2009–2015. PLoS One. 2017; 12(6): e0178677.
Published online 2017 Jun 1. Doi: [10.1371/journal.pone.0178677]
Access date: 15/03/ 2019.

32- Bhutta ZA, Das JK, Walker N, Rizvi A, Campbell H, Rudan I, Black RE. Interventions to address deaths from childhood pneumonia and diarrhoea equitably: what works and at what cost?. The Lancet. 2013 Apr 20;381 (9875):1417-29.
https://www.sciencedirect.com/science/article/pii/S0140673613606480
Access date: 16/ 07/ 2019.

33- Burnett E, Tate JE, Kirkwood CD, Nelson EA, Santosham M, Steele AD, Parashar UD. Estimated impact of rotavirus vaccine on hospitalizations and deaths from rotavirus diarrhoea among children< 5 in Asia. Expert review of vaccines. 2018 May 4;17 (5):453-60.
https://www.tandfonline.com/doi/abs/10.1080/14760584.2018.1443008
Access date: 14/03/ 2019.

34- Bambra C, Gibson M, Sowden A, Wright K, Whitehead M, Petticrew M. Tackling the wider social determinants of health and health inequalities: evidence from systematic reviews. Journal of Epidemiology & Community Health. 2010 Apr 1;64(4):284-91.
https://jech.bmj.com/content/jech/64/4/284.full.pdf
Access date: 16/ 05/ 2019.

35- Kakulu RK. Diarrhoea among under-five children and household water treatment and safe storage factors in Mkuranga district, Tanzania (Doctoral dissertation, Muhimbili University of Health and Allied Sciences).
https://core.ac.uk/download/pdf/11307835.pdf
Access date: 16/ 05/ 2019.

36- Miller P, Hirschhorn N. The effect of a national control of diarrheal diseases program on mortality: the case of Egypt. Social Science & Medicine. 1995 May 1;40 (10):S1-30.

file:///C:/Users/jawaid%20waak/Desktop/14,%20july%20thesis/Referece%20for%20Frameworks/Egyptedegyptncddp.pdf
Access date: 16/ 05/ 2019.

37- Weiss MG. Cultural models of diarrheal illness: conceptual framework and review. Social science & medicine. 1988 Jan 1;27(1):5-16.
https://www-sciencedirect-com.vu-nl.idm.oclc.org/science/article/pii/0277953688901591
Access date: 16/ 05/ 2019.

38- Genser B, Strina A, dos Santos LA, Teles CA, Prado MS, Cairncross S, Barreto ML. Impact of a city-wide sanitation intervention in a large urban centre on social, environmental and behavioural determinants of childhood diarrhoea: analysis of two cohort studies. International journal of epidemiology. 2008 Jul 23;37 (4):831-40.
https://academic.oup.com/ije/article/37/4/831/737013
Access date: 29/ 06/ 2019.

39- Wagner EG, Lanoix JN, World Health Organization. Excreta disposal for rural areas and small communities. World Health Organization; 1958.
https://apps.who.int/iris/bitstream/handle/10665/41687/WHO_MONO_39_(part1).pdf
Access date: 16/ 05/ 2019.

40- Gedamu G, Kumie A, Haftu D. Magnitude and associated factors of diarrhea among under five children in Farta wereda, North West Ethiopia. Quality in Primary Care. 2017;25(4):199-207.
https://www.researchgate.net/profile/Desta_Haftu/publication/319873870_Magnitude_and_Associated_Factors_of_Diarrhea_among_Under_Five_Children_in_Farta_Wereda_North_West_Ethiopia/links/59becbba0f7e9b48a2988980/Magnitude-and-Associated-Factors-of-Diarrhea-among-Under-Five-Children-in-Farta-Wereda-North-West-Ethiopia.pdf
Access date: 07/ 07/ 2019.

41- Mohanna MA, Al-Sonboli N. Prevalence of diarrhoea and related risk factors among children aged under 5 years in Sana'a, Yemen. Hamdan Medical Journal. 2018 Jan 1;11 (1):29.
http://www.hamdanjournal.org/temp/HamdanMedJ11129-196994_052819.pdf
Access date: 08/ 07/ 2019.

42- Ganguly E, Sharma PK, Bunker CH. Prevalence and risk factors of diarrhea morbidity among under-five children in India: A systematic review and meta-analysis. Indian journal of child health. 2015 Oct;2(4):152.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4764679/
Access date: 07/ 07/ 2019.

43- Boadi KO, Kuitunen M. Childhood diarrheal morbidity in the Accra Metropolitan Area, Ghana: socio-economic, environmental and behavioural risk determinants. Journal of Health & Population in Developing Countries. 2005 Mar 15;7:1-3.
https://www.researchgate.net/profile/Markku_Kuitunen/publication/285705706_Childhood_diarrheal_morbidity_in_the_Accra_Metropolitan_Area_Ghana_Socio-economic_environmental_and_behavioural_risk_determinants/links/5698f72908ae748dfaff3092.pdf

Access date: 11/ 07/ 2019.

44- Oliveira RK, Oliveira BS, Bezerra JC, Silva MJ, Melo FM, Joventino ES. Influence of socio-economic conditions and maternal knowledge in self-effectiveness for prevention of childhood diarrhea. Escola Anna Nery. 2017;21(4).
http://www.scielo.br/pdf/ean/v21n4/1414-8145-ean-2177-9465-EAN-2016-0361.pdf
Access date: 08/ 07/ 2019.

45- Thiam S, Diène AN, Fuhrimann S, Winkler MS, Sy I, Ndione JA, Schindler C, Vounatsou P, Utzinger J, Faye O, Cissé G. Prevalence of diarrhoea and risk factors among children under five years old in Mbour, Senegal: a cross-sectional study. Infectious diseases of poverty. 2017 Dec;6 (1):109.
https://idpjournal.biomedcentral.com/track/pdf/10.1186/s40249-017-0323-1
Access date: 08/ 07/ 2019.

46- Woldu W, Bitew BD, Gizaw Z. Socioeconomic factors associated with diarrheal diseases among under-five children of the nomadic population in northeast Ethiopia. Tropical medicine and health. 2016 Dec;44 (1):40.
https://tropmedhealth.biomedcentral.com/track/pdf/10.1186/s41182-016-0040-7
Access date: 08/ 07/ 2019.

47- Seid KW, Kelkay BD. The prevalence of diarrhea and associated factors among children under five years in Ethiopia. Int J Appl Res. 2018;4 (9):236-41.
https://www.researchgate.net/profile/Kassaye_Seid/publication/327941587_The_prevalence_of_diarrhea_and_associated_factors_among_children_under_five_years_in_Ethiopia/links/5bae518145851574f7ee950f/The-prevalence-of-diarrhea-and-associated-factors-among-children-under-five-years-in-Ethiopia.pdf
Access date: 08/ 07/ 2019.

48- Rashid IH, Abbas NA. A Hierarchical Model for Defining Priorities of Environmental and Non-Environmental Risk Factors of Childhood Diarrhea. Iraqi Journal of Medical Sciences. 2012;10 (4):348-55.
https://www.iasj.net/iasj?func=fulltext&aId=67202
Access date: 13/ 07/ 2019.

49- Ferrer SR, Strina A, Jesus SR, Ribeiro HC, Cairncross S, Rodrigues LC, Barreto ML. A hierarchical model for studying risk factors for childhood diarrhoea: a case–control study in a middle-income country. International Journal of Epidemiology. 2008 May 31;37 (4):805-15.
https://academic.oup.com/ije/article/37/4/805/736256
Access date: 17/ 07/ 2019.

50- Al-Hindi AI. Epidemiology of acute diarrheal diseases among Children under five in Gaza Strip: Post war community based study. Epidemiology of acute diarrheal diseases among Children under five in Gaza Strip: Post war community based study. 2017;5 (2B).
https://iugspace.iugaza.edu.ps/bitstream/handle/20.500.12358/25328/Al-Hindi%2c%20Adnan%20I._42.pdf?sequence=1&isAllowed=y
Access date: 08/ 07/ 2019

51- Karki T, Srivanichakorn S, Chompikul J. Factors related to the occurrence of diarrheal disease among under-five children in Lalitpur district of Nepal. Journal of Public Health and Development. 2010 Oct 14;8 (3):237-51.
https://www.tci-thaijo.org/index.php/AIHD-MU/article/view/105552/83780
Access date: 17/ 07/ 2019.

52- Turley R, Saith R, Bhan N, Rehfuess E, Carter B. Slum upgrading strategies and their effects on health and socio-economic outcomes A systematic review August 2013.
https://www.3ieimpact.org/sites/default/files/2017-08/sr13-slum-upgrading-strategies-review.pdf
Access date: 10/ 07/ 2019.

53- United Nations-HABITAT; Afghanistan. State of Afghan Cities- report; Volume-II, 2015.
https://unhabitat.org/books/soac2015_volume2/
Access date: 10/ 07/ 2019.

54- Hunter PR, Risebro H, Yen M, Lefebvre H, Lo C, Hartemann P, Longuet C, Jaquenoud F. Water source and diarrhoeal disease risk in children under 5 years old in Cambodia: a prospective diary based study. BMC Public Health. 2013 Dec;13(1):1145.
https://bmcpublichealth.biomedcentral.com/track/pdf/10.1186/1471-2458-13-1145
Access date: 16/ 07/ 2019.

55- Stelmach R, Clasen T. Household water quantity and health: a systematic review. International journal of environmental research and public health. 2015 Jun;12(6):5954-74.
https://www.mdpi.com/1660-4601/12/6/5954
Access date: 11/ 07/ 2019.

56- World Health Organization. Water, Sanitation and Hygiene. Geneva 2007
https://apps.who.int/iris/bitstream/handle/10665/43763/9789241595759_eng.pdf?sequence=1
Access date: 17/ 07/ 2019.

57- Godana W, Mengiste B. Environmental factors associated with acute diarrhea among children under-five years of age in Derashe district, Southern Ethiopia. Sci J Public Health. 2013 Jan;1(3):119-24.
https://pdfs.semanticscholar.org/ae0c/63fe03113b6368e5cdcb361645588536b4e9.pdf
Access date: 11/ 07/ 2019.

58- Kumar S, Vollmer S. Does access to improved sanitation reduce childhood diarrhea in rural India?. Health Economics. 2013 Apr;22 (4):410-27.
https://onlinelibrary-wiley-com.vu-nl.idm.oclc.org/doi/epdf/10.1002/hec.2809
Access date: 13/ 07/ 2019.

59- Fattah NM. The Effect of Colors on the Attraction and Aggregation of the Houseflies (Musca domestica L.). College Of Basic Education Researches Journal. 2012;11 (3):759-64.
https://www.iasj.net/iasj?func=fulltext&aId=26133
Access date: 15/ 07/ 2019.

60- Woldemicael G. Diarrhoeal morbidity among young children in Eritrea: environmental and socioeconomic determinants. Journal of health, population and nutrition. 2001 Jun 1:83-90.
https://www.jstor.org/stable/23498677?seq=1#page_scan_tab_contents
Access date: 15/ 07/ 2019.

61- George CM, Oldja L, Biswas SK, Perin J, Lee GO, Ahmed S, Haque R, Sack RB, Parvin T, Azmi IJ, Bhuyian SI. Fecal markers of environmental enteropathy are associated with animal exposure and caregiver hygiene in Bangladesh. The American journal of tropical medicine and hygiene. 2015 Aug 5;93 (2):269-75.
http://www.ajtmh.org/docserver/fulltext/14761645/93/2/269.pdf?expires=1563200044&id=id&accname=guest&checksum=CCE80895E331B02604983359C80A7829
Access date: 15/ 07/ 2019.

62- George CM, Oldja L, Biswas S, Perin J, Lee GO, Kosek M, Sack RB, Ahmed S, Haque R, Parvin T, Azmi IJ. Geophagy is associated with environmental enteropathy and stunting in children in rural Bangladesh. The American journal of tropical medicine and hygiene. 2015 Jun 3;92 (6):1117-24.
http://www.ajtmh.org/docserver/fulltext/14761645/92/6/1117.pdf?expires=1563202379&id=id&accname=guest&checksum=CAD25805100D64FEDA41C25D91197A56
Access date: 15/ 07/ 2019.

63- World Bank Group. Climate Change Knowledge Portal, Afghanistan. 2019.
https://climateknowledgeportal.worldbank.org/country/afghanistan
Access date: 16/ 07/ 2019.

64- Flood list. Articles and Reports, Afghanistan. 2017- 2019.
http://floodlist.com/tag/afghanistan
Access date: 16/ 07/ 2019.

65- Genser B, Strina A, Teles CA, Prado MS, Barreto ML. Risk factors for childhood diarrhea incidence: dynamic analysis of a longitudinal study. Epidemiology. 2006 Nov 1:658-67.
https://www-jstor-org.vu-nl.idm.oclc.org/stable/pdf/20486295.pdf?refreqid=excelsior%3A744cc1793005a4a105d3ba9d904bebb8
Access date: 17/ 07/ 2019.

66- Getachew A, Tadie A, Hiwot MG, Guadu T, Haile D, Cherkos TG, Gizaw Z, Alemayehu M. Environmental factors of diarrhea prevalence among under five children in rural area of North Gondar zone, Ethiopia. Italian journal of pediatrics. 2018 Dec;44 (1):95.
https://www.ncbi.nlm.nih.gov/pubmed/30115077
Access date: 17/ 07/ 2019

67- Forouhar A, Hristovski KD. Characterization of the municipal solid waste stream in Kabul, Afghanistan. Habitat International. 2012 Jul 1;36 (3):406-13.

https://www-sciencedirect-com.vu-nl.idm.oclc.org/science/article/pii/S0197397512000021

Access date: 17/ 07/ 2019.

68- Dessalegn M, Kumie A, Tefera W. Predictors of under-five childhood diarrhea: Mecha District, west Gojam, Ethiopia. Ethiopian journal of health development. 2011;25 (3):192-200.
https://www.ajol.info/index.php/ejhd/article/view/83811/73820
Access date: 10/ 07/ 2019.

69- Stephanie A. Richard, Robert E. Black, Robert H. Gilman, Richard L. Guerrant et al. Wasting Is Associated with Stunting in Early Childhood. Childhood Infection and Malnutrition Network, *The Journal of Nutrition* July 2012 Volume 142, Issue 7.
https://academic.oup.com/jn/article/142/7/1291/4743490
Access date: 22/ 07/ 2019.

70- Wierzba TF, El-Yazeed RA, Savarino SJ, Mourad AS, Rao M, Baddour M, El-Deen AN, Naficy AB, Clemens JD. The interrelationship of malnutrition and diarrhea in a periurban area outside Alexandria, Egypt. Journal of paediatric gastroenterology and nutrition. 2001 Feb 1;32 (2):189-96.
https://journals.lww.com/jpgn/Fulltext/2001/02000/The_Interrelationship_of_Malnutrition_and_Diarrhea.18.aspx#pdf-link
Access date: 22/ 07/ 2019.

71- Curtis V, Cairncross S. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. The Lancet infectious diseases. 2003 May 1;3(5):275-81.
https://www-sciencedirect-com.vu-nl.idm.oclc.org/science/article/pii/S1473309903006066
Access date: 22/ 07/ 2019.

72- Walker et al. Diarrhea incidence in low- and middle-income countries in 1990 and 2010: a systematic review- *BMC Public Health.* 2012.
https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-220
Access date: 03/ 07/ 2019.

73- Pakistan Demographic and Health Survey 2017-2018.
https://dhsprogram.com/pubs/pdf/FR354/FR354.pdf
Access date: 03/ 07/ 2019.

74- Melo MC, Taddei JA, Diniz-Santos DR, Vieira C, Carneiro NB, Melo RF, Silva LR. Incidence of diarrhea in children living in urban slums in Salvador, Brazil. Brazilian Journal of Infectious Diseases. 2008 Feb;12 (1):89-93.
http://www.scielo.br/scielo.php?pid=S1413-86702008000100019&script=sci_arttext&tlng=pt
Access date: 03/ 07/ 2019.

75- Ministry of Public Health- Afghanistan. Environmental Health Policy. 2010.
http://old.moph.gov.af/Content/Media/Documents/EnvironmentalHealthPoliyDraft201029920122105386755332 5325.pdf
Access date: 24/ 07/ 2019.

76- Danish Committee for Aid to Afghan Refugees (DAACAR) - Afghanistan. Water, Sanitation and Hygiene. 2019.
https://www.dacaar.org/functions/howwework/wash-water-sanitation-and-hygiene.php

Access date: 24/ 07/ 2019.

77- United States Agency for International Development. Water and Development Country Plan for Afghanistan. 2016.
https://files.globalwaters.org/water-links-files/Afghanistan%20Country%20Plan%20final_0.pdf
Access date: 24/ 07/ 2019.

78- The World Bank. Urban Water Supply and Sanitation Grant for Afghanistan. 2006
http://documents.worldbank.org/curated/en/744791468194995521/pdf/t76600rev0pdf.pdf
Access date: 24/ 07/ 2019.

79- Ministry of Rural Rehabilitation & Development- Afghanistan. National Rural Water, Sanitation, and Hygiene (WASH) Policy 2010.
http://www.ruwatsip-mrrd.gov.af/Attachements/English/WASH%20Policy%202010_323.pdf
Access date: 24/ 07/ 2019.

80- Ministry of Finance (MOF) - Afghanistan. National Infrastructure Plan. 2017- 2020.
http://policymof.gov.af/home/wp-content/uploads/2019/01/Natioal-Infrastructure-NPP.pdf
Access date: 24/ 07/ 2019.

81- Ministry of Rural Rehabilitation & Development- Afghanistan. National Rural Water, Sanitation, and Hygiene (WASH) Policy 2016-2020.
https://www.ruwatsip-mrrd.gov.af/Attachements/English/WASH%20Policy-2016-2020_173.pdf
Access date: 24/ 07/ 2019.

82- United Nations International Children's Emergency Fund (UNICEF) - Afghanistan. Water, sanitation and Hygiene report. 2019.
https://www.unicef.org/afghanistan/wash-water-sanitation-and-hygiene
Access date: 24/ 07/ 2019.

83- Ministry of Public Health- Afghanistan. National Hygiene Promotion Strategy 2017-2020.
http://old.moph.gov.af/Content/files/eng_National%20Hygiene%20Promotion%20Strategy%202017-2020.pdf
Access date: 24/ 07/ 2019.

84- Ministry of Public Health- Afghanistan. National Health Policy (NHP) 2015- 2020.
http://old.moph.gov.af/Content/Media/Documents/NationalHealthPolicy(NHP)2015-2020December2015endoursed247201615435541553325325.pdf
Access date: 25/ 06/ 2019.

85- Eastern Mediterranean Regional Office- WHO. EPI final report, Afghanistan. 2017
http://www.emro.who.int/images/stories/afghanistan/AFG_EPI_review_report_Final.pdf
Access date: 27/ 07/ 2019.

86- Eastern Mediterranean Regional Office- WHO. Expanded program on immunization- Afghanistan. 2019.
http://www.emro.who.int/afg/programmes/epi.html

Access date: 27/ 07/ 2019.

87- General Directorate of Preventive Medicine, MOPH- Afghanistan. National Public Nutrition Policy and Strategy 2015- 2020.
http://nutritionmoph.gov.af/download-view/public_nutrition_policy_strategy_2015/
Access date: 27/ 07/ 2019.

88- Ministry of Public Health- Afghanistan. National Reproductive, Maternal, newborn, Child and Adolescent health (RMNCAH) Strategy. 207-2021.
http://old.moph.gov.af/Content/files/National%20RMNCAH%20Strategy%202017-2021%20English-Final.pdf
Access date: 27/ 07/ 2019.

89- General Directorate of Preventive Medicine. MOPH- Afghanistan. Public Nutrition Policy & Strategy; 2009- 2013.
http://old.moph.gov.af/Content/Media/Documents/PublicNutritionPolicyStrategy2009-20133092012926407705533325325.pdf
Access date: 27/ 07/ 2019.

90- Mitra AK, Rahman MM, Fuchs GJ. Risk factors and gender differentials for death among children hospitalized with diarrhoea in Bangladesh. Journal of Health, Population and Nutrition. 2000 Dec 1:151-6.
https://www.jstor.org/stable/23498871?seq=1#page_scan_tab_contents
Access date: 22/ 07/ 2019.

91- Pandey A, Sengupta PG, Mondal SK, Gupta DN, Manna B, Ghosh S, Sur D, Bhattacharya SK. Gender differences in healthcare-seeking during common illnesses in a rural community of West Bengal, India. Journal of Health, Population and Nutrition. 2002 Dec 1:306-11.
https://www.jstor.org/stable/23498918?seq=1#page_scan_tab_contents
Access date: 22/ 07/ 2019.

92- Logistic Capacity Assessment. Afghanistan Waste Management and Disposal Providers. 2018.

https://dlca.logcluster.org/display/public/DLCA/3.7+Afghanistan+Waste+Management+and+Disposal+Providers
Access date: 22/ 07/ 2019.

93- World Health Organization. Health Statistics and Information System.
https://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/
Access date: 08/ 08 /2019.

94- Harvard, School of Public Health. Prevalence and Incidence Defined.
https://www.hsph.harvard.edu/obesity-prevention-source/prevalence-incidence/
Access date: 08/ 08 /2019.

95- The World Bank. What are Poverty Lines?
https://www.worldbank.org/en/news/video/2017/04/14/what-are-poverty-lines
Access date: 08/ 08 /2019.
96- The United Nations Educational, Scientific and Cultural Organization (UNESCO)- Definitions.
https://www.unicef.org/infobycountry/stats_popup5.html

Access date: 01/ July/2019.

97- World Health Organization. Health Situation and trend Assessment.
http://www.searo.who.int/entity/health_situation_trends/data/chi/population-growth-rate/en/
Access date: 08/ 08 /2019.

98- Simcoe Muskoka. Health Stats. Fertility Rate.
http://www.simcoemuskokahealthstats.org/topics/pregnancy-and-before/birth-and-fertility-rates/total-general-fertility-rates
Access date: 08/ 08 /2019.

99- World Health Organization. Health Situation and trend Assessment
http://www.searo.who.int/entity/health_situation_trends/data/chi/TFR/en/
Access date: 01/ July/2019.

100- The World Bank. Data Catalog. Human Development Index.
https://datacatalog.worldbank.org/human-development-index-hdi
Access date: 08/ 08 /2019.

101- Stat Trek. Statistical Dictionary.
https://stattrek.com/statistics/dictionary.aspx?definition=z_score
Access date: 08/ 08 /2019.

102- Hoffmann K, Pischon T, Schulz M, Schulze MB, Ray J, Boeing H. A statistical test for the equality of differently adjusted incidence rate ratios. American journal of epidemiology. 2008 Jan 29;167 (5):517-22.
https://www.ncbi.nlm.nih.gov/pubmed/18230678
Access date: 08/ 08 /2019.

Annex 1: Map of Afghanistan (9).

Annex 2: Search Table and Keywords

Objectives	Search Strategies	Search Engines and Access sources
- **Introduction** and **Background** Information **- Problem Statement**	"Afghanistan" AND geography, "Afghanistan" AND demography, "political environment" AND Afghanistan, "BPHS" AND Afghanistan, "EPHS" AND Afghanistan, "demographic and health survey" AND Afghanistan, "acute diarrhea" OR diarrhoea AND LMICs, "Acute diarrhea" AND worldwide, "acute diarrhea" OR diarrhoea NOT chronic, "acute diarrhea" AND Africa, " under-five diarrhea " AND Pakistan OR India, "diarrhea policies" AND Afghanistan, "diarrhea strategies" OR diarrhoea strategies AND Afghanistan, "health system" AND Afghanistan, "demographic and health survey" AND Pakistan, "acute diarrhea" AND Yemen, "diarrhea" OR diarrhoea AND control Strategies, "socio-economical factors" AND diarrhea, "diarrhea" AND consequences, "diarrhea" OR diarrhoea AND causes, اسهال در اطفال، اسهال در اطفال زیر پنج سال در افغانستان، اسهال په ماشومانو کی او افغانستان	Google, CSO, WHO, USAID, UNESCO, World Bank, MOPH, GMJs, VU e-library, PubMed, Google Scholar
Objective# 1 - Socio- economical and environmental factors causing diarrheal diseases in under-five children in Afghanistan.	"acute diarrhea" AND under five, diarrhea AND U5, " socio-economic factors " AND acute diarrhea AND Afghanistan, "Diarrhoea" OR diarrhea in under-5 years, "diarrhoea" in under-5 AND low and middle income countries, "prevalence" OR Incidence AND diarrhea, "risk factors" AND diarrhea OR diarrhoea, "diarrhea"[chronic] OR diarrhoea AND LMIC, "Under five diarrhea" AND low and middle income countries, "economical factors" AND diarrhea AND LMIC, , environmental factors* AND diarrhea OR diarrhoea, "WASH" AND diarrhea OR diarrhoea, "Acute diarrhea" NOT chronic, "acute diarrhea" AND less than five, Malnutrition AND diarrhea OR diarrhoea, "Nutritional status" AND diarrhea, "social factors" AND diarrhea AND Afghanistan, "environmental factors" AND diarrhea AND LMIC, "WASH"AND Afghanistan "environmental factors" AND diarrhea AND Pakistan, "socio- economic factors" AND diarrhea AND LMICs, "Mothers education level" AND diarrhea, "Sanitation" AND diarrhea," hygiene" AND diarrhea, Age AND diarrhea, Sex AND diarrhea, "living condition" AND Afghanistan, "Improved water" AND diarrhea, " socio- economic " AND diarrhea AND Pakistan, "living condition" AND diarrhea OR diarrhoea, "associated factors" AND diarrhea AND Bangladesh, "associated factors" AND diarrhea AND Afghanistan, "associated factors" AND diarrhea AND Pakistan, "diarrhea" AND sewage AND LMIC, "paved streets" AND diarrhea AND LMICs, "diarrhea" AND streets AND Afghanistan, "garbage collection" AND Afghanistan, "diarrhea" OR diarrhoea AND garbage " diarrhea " OR diarrhoea AND quantity of water AND LMICs, "diarrhea" AND source of water AND LMICs, "dwelling" AND diarrhea AND LMICs, "habitation" AND diarrhea, " diarrhea " AND habitation OR house OR dwelling OR slum, , "diarrhea" AND painting, "diarrhea" AND wall's color, "diarrhea " AND flooding, " diarrhea " AND flooding AND Afghanistan, "diarrhea" OR diarrhoea AND household flooding AND Afghanistan, "diarrhea" OR diarrhoea AND separate kitchen اسهال در اطفال، اسهال در اطفال زیر پنج سال، اسهال په ماشومانو کی او افغانستان	PubMed, Google Scholar, Google, CSO, WHO, USAID, UNESCO, World Bank, MOPH, GMJs, VU e-library,

Objective# 2 Role of feeding, breast feeding and nutritional status of the child in occurrence of diarrheal diseases in under-five children in Afghanistan.	"diarrhea" OR diarrhoea AND feeding, "diarrhea" OR diarrhoea AND nutrition, "diarrhea" OR diarrhoea AND birth weight, "low birth weight" AND diarrhea, "malnutrition" AND acute diarrhea OR diarrhoea, "diarrhea" OR diarrhoea AND breast feeding, "diarrhea" AND duration of breast feeding, malnutrition* AND diarrhea AND LMIC, "wasting" OR stunting AND diarrhea OR diarrhoea, "diarrhea" AND marasmus OR kwashiorkor, "diarrhea" AND anthropometric measures OR malnutrition, "acute diarrhoea" OR diarrhea [chronic] AND malnutrition,	PubMed, Google Scholar, Google, VU e-library, WHO, USAID, UNESCO, World Bank, MOPH-Afghanistan
Objective# 3 To review the current policies and strategies regarding controlling diarrheal diseases in under-five children in Afghanistan; including WASH interventions	"WASH"AND Afghanistan, "intervention" AND WASH AND Afghanistan, "water, sanitation and hygiene" AND Afghanistan, "diarrhea" OR diarrhoea interventions AND Afghanistan, "water" AND sanitation AND hygiene AND Afghanistan, "WASH" AND policy AND Afghanistan, "WASH" AND strategy AND Afghanistan, "diarrhea" OR diarrhoea AND preventive strategies, "diarrhea" AND prevention AND Afghanistan, "nutrition" AND diarrhea AND Afghanistan, "nutritional strategy" OR nutritional policy AND Afghanistan, "vaccination" AND diarrhea AND Afghanistan, "policies" AND MOPH OR Afghanistan,	PubMed, Google Scholar, Google, VU e-library, WHO, USAID, UNESCO, World Bank, MOPH-Afghanistan

Annex- 2 continued…

Annex 3: Generic Conceptual Framework (38).

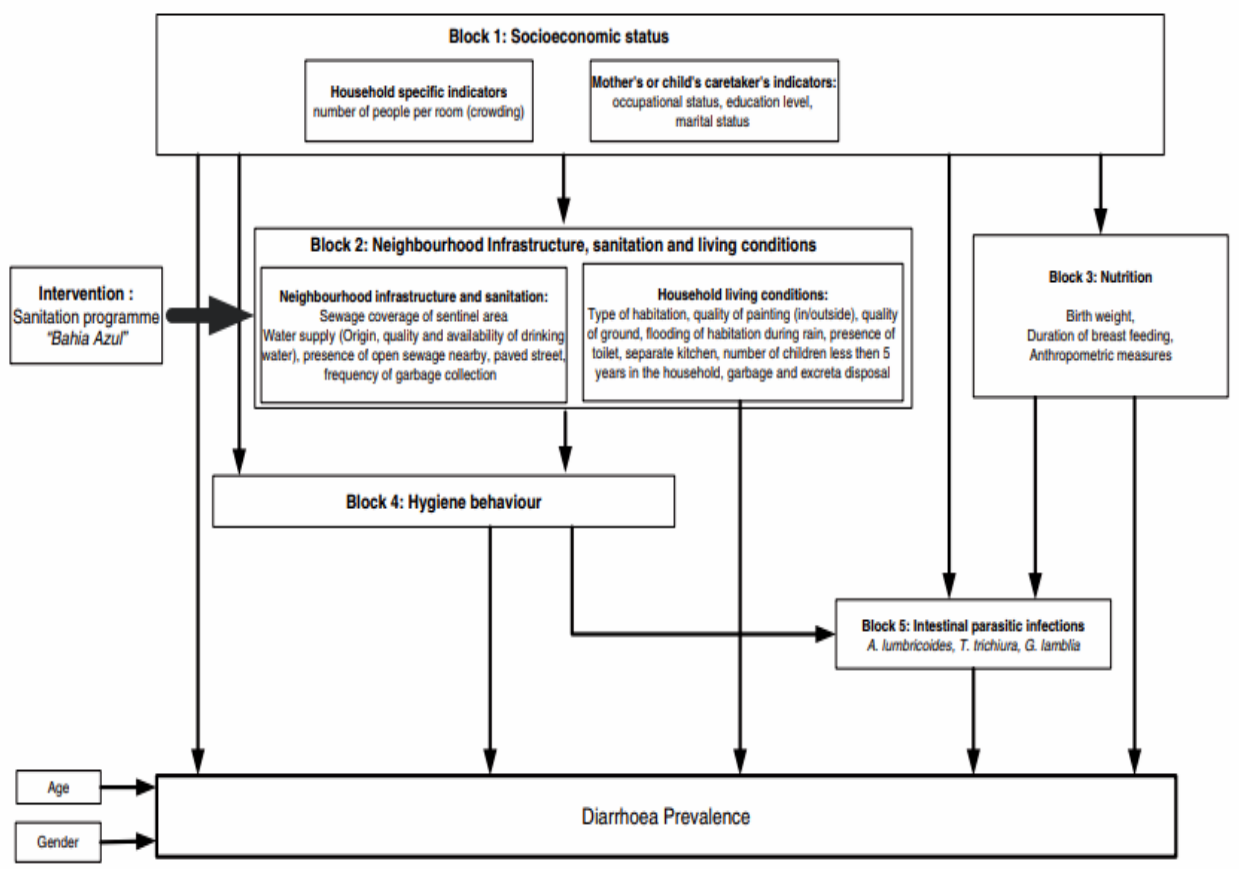


Figure 1 Conceptual framework visualizing the inter-relationships between potential risk factors, the sanitation intervention and diarrhoea prevalence

Annex 4: Glossary of Definitions and Key terms

1. **DALYs (disability adjusted life years):** One year of "healthy life" lost is called one DALY. DALYs are being used to measure the gap between current health condition of the population, and an ideal health status that results to advanced age, free of disability and diseases (93).

2. **Adequate Sanitation or "Safely managed"- services or sanitation:** Improved sanitation facility where human excreta are removed or disposed in situ or transported & treated off- site and not shared among the households (12).

3. **Slum apartment:** Low- standard shack or a dwelling compound occupied by > 2 households (43).

4. **Incidence of diarrhea:** The number of people who develop diarrhea during a specific time period (as month or year) (94).

5. **Prevalence of diarrhea in children:** Total number of children with diarrhea divided by total number of children surveyed, and shown by percentage (40).

6. **Prevalence Ratio (PR):** The ratio of proportion of the people with the disease over the proportion with exposure only (38).

7. **Open defecation or no- service:** Where human faeces are disposed of on grounds, fields, bushes, forests, beaches or other open bodies of water or disposed of in garbage (12).

8. **Improved toilet or sanitation facilities:** Those facilities that hygienically separate human faeces from human contact as well as not shared among the households like: flush toilets attached to closed- sever system or septic tank, pit type of latrines with slabs, ventilated improved pits, pit latrines and composting toilets (12).

9. **Unimproved sanitation facilities:** flush toilets attached to open- sewer system or elsewhere other than closed-sewer, pit latrines without slabs, hanging latrines or toilets, buckets, or no- facilities as open defecation (40).

10. **Improved water sources:** They are protected from outside contamination and include: public taps, piped water, tube wells, standpipes, protected springs or dug wells, bore holes and rain water (5).

11. **Safely managed water sources:** Improved water sources; located on premises, free from chemical and faecal contamination and available when needed (12).

12. **Basic services for water:** Water from improved sources; collected within 30 minutes (round trip, including queuing) (12).

13. **Unimproved water:** Water from unprotected spring as well as dug well, tanker truck, cart with small drum/ tank, bottled water and surface water (5, 12).

14. **No services of water:** People drinks water; directly from stream, river, pond, dam, lake, canal or irrigation canal (12).

15. **National poverty line:** A defined poverty line by a country which shows; that those people who are below this line don't have enough money for basic needs and infrastructures as housing, foods, clothing etc (95).

16. **Net primary school enrolment ratio or Net school Attendance Ratio in primary school (NAR):** Number of enrolled children in primary school (in officially determined age for primary school), divided by total number of people in the same age group in the population (96).

17. **Adult literacy rate:** Percentage of people aged 15 years and above; who can read and write (96).

18. **Population growth rate:** "Annual population growth rate is an average exponential rate of annual growth of the population over a given period which is usually quinquennial (5 year) period" (97).

    OR

    The rate at which the number of people in a population increases; in a given period of time and expressed as a fraction of the initial population.

$$Population\ growth\ rate = \frac{P(t_2) - P(t_1)}{P(t_1)(t_2 - t_1)}$$

19. **Fertility rate (FR):** Number of live births/1000 women of 15-49 years age (reproductive age), per year (98).

20. **Total Fertility Rate (TFR):** "total number of children born or likely to be born to a woman in her life time if she were subject to the prevailing rate of age-specific fertility in the population" (99).

21. **Treated drinking water:** Unimproved water can be improved to drink after treatment with chlorination, boiling, sun light, filtering and straining in cloth (35).

22. **Human Development Index (HDI):** Is the summary measure of human development. By HDI, Achievements in the country can be measured in three dimensions as: access to knowledge, access to a descent standard of living and healthy and long life (101).

23. **Limited services for water:** Water from improved sources; collected in more than 30 minutes (round trip, including queuing) (12).

24. Maternal self- efficacy regarding diarrheal diseases: Maternal knowledge about some of the risk factors and preventive measures which could increase/ decrease diarrheal diseases in their children such as; knowledge about sanitary conditions as garbage destination, type of sewage and sanitary type; home hygiene, bottle hygiene, breast feeding provision hygiene, washing hands and utensils with soap (44).

25. Z- score: A z- score shows; how many standard deviations an element is from the mean (101).

Interpretation of z- scores:

- Z- Score < 0 shows that the element is lower than the mean.
- Z- Score > 0 shows that the element is greater than the mean.
- Z- Score = 0 shows that the element is equal to the mean.
- Z- Score = 1 shows that the element is one standard deviation greater than the mean.
- Z- Score= -1 shows that the element is one standard deviation lower than the mean, -2 represents an element two standard deviation below the mean, etc.

- "If the number of elements in the set is large, about 68% of the elements have a z-score between -1 and 1; about 95% have a z-score between -2 and 2; and about 99% have a z-score between -3 and 3".

26. Standard Deviation (SD): "A numerical value used to indicate how widely individuals in a group vary". The greater the variation of an observation from the group mean; the bigger the standard deviation and vice versa (101).

27. Incidence Rate Ratio (IRR): Is the ratio of two incidence rates (IR). IR is defined as the number of events or disease- episodes divided by the person- time at risk. IRR is a very good effect measure in epidemiology, especially when adjusted for all common confounders.

28. Sentinel Areas: where the disease prevalence is higher (38).