CHARACTERIZATION OF RISK FACTORS, MORBIDITY, AND MORTALITY ASSOCIATED WITH DIARRHEAL DISEASE AMONG CHILDREN UNDER FIVE (CU5) IN EAST AFRICAN REFUGEE CAMPS

By

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To my wife, my children, the United Nation High Commissioner for Refugees (UNHCR) team in Geneva, and friends at the University of Florida

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LIST OF ABBREVIATIONS

CAR	Central African Republic
CFR	Case Fatality Rate
CI	Confidence Intervals
CU5	Children Under Five
DRC	Democratic Republic of Congo
GAM	Global Acute Malnutrition
GI	Gastrointestinal
GRADE	Grades Recommendation, Assessment, Development and Evaluation (GRADE).
HFU	Health Facility Utilization
HH	Household
HIS	Health Information System
IDP	Internally Displaced People
IRC	International Rescue Committee
IRR	Incident Rate Ratio
MOR	Matched Odds Ration
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
UNHCR	United Nation High Commissioner for Refugees
WASH	Water And Sanitation, Hygiene
WOS	Web of Science

Abstract of Dissertation Presented to the Graduate School
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Diarrheal disease remains the third leading cause of death globally among Children Under Five (CU5), an estimated one in 10 CU5 dies from diarrheal disease. Diarrheal disease is a leading cause of both morbidity and mortality among children living in low-income countries, thus much of the literature focuses on CU5 in developing countries. However, despite the additional vulnerability of refugee status, very little research on diarrheal disease has been conducted within refugee camps.

This research reviews relevant data on the risk factors associated with diarrheal disease, as reported the published peer review literature, then using an analysis of United Nation High Commissioner for Refugees (UNHCR) - Health Information System (HIS) data. The objective of the research is to identify-patterns of diarrheal morbidity and mortality among CU5 in East African Refugee camps, and to identify key risk factors associated with this disease, so to better target interventions and improve health outcomes of children in these camps.

CHAPTER 1
OPENING REMARKS

History and Mandate of United Nations High Commissioner for Refugees (UNHCR) People of Concern.

The United Nation High Commissioner for Refugees (UNHCR) is authorized by the United Nations (UN) to lead in the protection of refugees and coordination of refugee programs worldwide [1].UNHCR was originally established in 1950 to help refugees who had lost homes and fled to neighboring countries for safety [2]. For more than 67 years, UNHCR has been helping and protecting refugees, having assisted an estimated 65.6 million forcibly displaced people worldwide [2, 3]. UNHCR defines a refugee as someone who meets following criteria:

> 1) Has been considered a refugee under the arrangements of 12 of May 1926 and 30 June 1928 or under the Conventions of 28 October 1933 and 10 February 1938, the Protocol of 14 September 1939 or the Constitution of the International Refugee Organization [IRO); decisions of non-eligibility taken by the [IRO] during the period of its activities shall not prevent the status of refugee being accorded to persons who fulfil the conditions of paragraph 2 of this section [4].
>
> 2) As a result of events occurring before 1 January 1951 and owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion is outside the country of his nationality and is unable or owing to such fear. Is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or owing to such fear, is unwilling to return to it [4].

As of 2016, the total number of people forcibly displaced in the world was estimated to be 65.6 million [3]. Of these, 22.5 million are refugees (17.2 million under UNHCR mandate and 5.3 million Palestinian refugees) as registered by United Nations Relief and Workers Agency (UNRWA) [5]. The remaining people are largely internally

displaced people (IDP) (40.3 million), which is similar to a refugee but has not crossed an international border, and asylum-seekers (2.8 million).

In the same year, 2016, 55% of refugees came from three countries: South Sudan (1.4 million), Afghanistan (2.5 million), and Syria (5.5 million) [3].Countries that hosted the greatest number of refugees in the same year included Ethiopia (791,600), Uganda (940,800), Islamic Republic of Iran (979,400), Lebanon (1.0 million), Pakistan (1.4 million), and Turkey (2.9 million) [3]. An estimated 51% of refugee population are children under 18 years of age [5].

Refugees in sub-Sahara Africa

UNHCR has documented that sub-Saharan Africa is home to the majority of refugees globally, a reality that is largely driven by conflict in the following countries: Burundi, the Central African Republic (CAR), the Democratic Republic of the Congo (DRC), Eritrea, Somalia, South Sudan, and Sudan [5]. In 2016, the global distribution of displaced people worldwide included those hosted in in Africa (30%), the Middle East and North Africa (26%), Europe (17%), Americas (16%), and Asia and Pacific (11%) [3].

In 2016, conflicts in sub-Saharan Africa caused significant refugee movement in the following countries: Nigeria (64,700), Eritrea (69,600) , Burundi (121,700), and South Sudan (737,400) [5]. There was a sharp increase in the number of refugees coming into Uganda in 2016, with the greatest numbers coming from South Sudan (639,000 people), DRC (205,400), Burundi (41,000), Somalia (30,700), and Rwanda (15,200) [5]. Similarly to Uganda, the number of refugees in Ethiopia increased tremendously in 2016, with a majority of refugees coming from South Sudan (338,800), Eritrea (165,000), and Sudan (39,900) [5].

During the same timeframe, the refugee population in Kenya included those from South Sudan (87,100), DRC (13,000), and Ethiopia (19,100) [5]. The DRC hosted an estimated 452,000 refugees in 2016, coming primarily Rwanda (245,100), South Sudan (66,700), and Burundi (36,300) [5]. These data illustrate that the ongoing conflict in South Sudan is a major source of displacement for people throughout the region. Regarding South Sudan and the refugee crisis, the UNHCR states the following:

> The fastest-growing refugee population was spurred by the crisis in South Sudan. This group grew by 64% during the second half of 2016 from 854,100 to over 1.4 million, the majority of whom were children [5].

There is a growing concern that the number of refugees has and will continue to rise through the end of 2017. Because internal fighting and civil war conflicts within South Sudan erupt without warning, refugees are forced to flee to neighboring countries rather than displacing internally [6]. It has been projected that civil war conflicts in sub-Saharan Africa will continue to displace more refugees if there is no peaceful settlement, which has important implications at national and regional levels, as these refugees return to their country of origin [6].

Diarrheal disease is the third leading cause of disease burden and is the cause of death for an estimated 7.6 million CU5 annually [7] . A previously noted, 51% of the total refugee population worldwide are CU5. The majority of children who die from diarrheal diseases reside in sub-Saharan Africa and South Asia [8]. Thus, the next section will explore refugees as a particularly vulnerable population for diarrheal disease.

Refugees as a Vulnerable Population for Diarrheal Disease

Much of previous research on diarrheal disease has been conducted on CU5 in low-income countries, but little research has been conducted within refugee camps. As

such, robust data about diarrheal morbidity and mortality among refugee children under five are lacking. It has been estimated that 86% of refugees worldwide are hosted in low-income countries [9], and most refugees rely on international aid to provide them with food, safe water, and basic health care delivery [10].

In refugee camps, known risk factors for diarrheal disease are common. Difficult but typical conditions of camps often include overcrowding, a lack of access to clean water and sanitation, inadequate shelter, and exposure to violence. Because refugee camp populations typically come from various geographic areas, refugee populations within camps risk exposure to new pathogens. Paquet and colleague noted in their 1998 study that because of the push factors associated refugee migration, refugees find themselves in new locations where they are highly vulnerable to pathogens that may have long existed in that area but are new to the refugees [10]. These factors combine to create a heightened level of biologic vulnerability among refugee populations, both compared to their populations at home, as well as compared to populations surrounding the camps in host countries. This can increase the risk of diarrheal disease among refugees living in camps, particularly among CU5.

A study looking at incidence and risk factors for diarrhea in CU5 in UNHCR camps across 16 countries found that 7% of mortality and 7% of morbidity in CU5 are attributable to diarrheal diseases [11]. The researchers analyzed data from UNHCR-HIS to estimate the incidence and risk factors for diarrheal disease among CU5 in UNHCR-run refugee camps.

A study by Boru et al., (2013) investigate the etiology of and factors associated with bacterial diarrheal diseases amongst urban refugees in Nairobi, Kenya. This study found the following characteristics to be associated with diarrheal disease:

- children not washing their hands with soap;
- children not exclusively breastfed;
- children having eaten food cooked the previous day;
- neighbors having had diarrhea;
- children sharing a toilet with a diarrhea patient; and
- children drinking water from outside the home [12].

In the two UNHCR refugee camps in Kenya (Dadaab and Kakuma), conditions match those previously described as promoting increased risk for diarrheal disease and outbreaks. Overcrowding, insufficient housing, poor nutritional status, and inadequate WASH are rampant [11, 13, 14]. In Dadaab, Tepo et al. [15], documented outbreaks of *cholera,* and *shigellosis* and *cholera* outbreaks have also been documented in Kakuma [16, 17]. These data suggest that both outbreaks and endemic sources of diarrheal disease are likely present in refugee camps and driving rates of diarrheal disease.

Schultz and colleagues [16] found that sharing a latrine with three or more households and being a recent arrival in the camp were associated with increased risk for contracting cholera [16]. Another example of risk factors identified within the refugee setting is published by Mahamud and colleagues who found a significant association between the presence of dirty water storage containers and the incidence of cholera [17].

Outbreaks of diarrheal disease similar to those seen in Kenyan camps have been observed in other refugee settings in Africa. For instance, during the Rwandan Civil War

in 1994, an estimated 20,000 Rwandan refugees died in the first month due to an outbreak of *Shigella dysenteriae type 1* [13]. Previous research indicates diarrheal diseases often occur in refugee settings in the form of a disease outbreak; however, there is a lack of epidemiologic data indicating the endemic state of acute watery diarrhea (AWD) or *cholera* among CU5 living in an East African refugee camps. For this research thesis, the focus will consist of characterization of risk factors, morbidity, and mortality associated with diarrheal disease in CU5 across East African refugee camps, from 1996- 2016.

Research Questions

In order for policy and other decision-makers to effectively address morbidity and mortality associated with diarrheal disease among refugee children, it is essential that improve the evidence base for understanding the risk factors of diarrheal disease within this population. Doing so may enable Non-Governmental Organization (NGOs), UNHCR, and other agencies to better coordinate health interventions or programs or improve policies to facilitate healthcare access in these refugee camps. In the end, they may be able to mitigate the risk of childhood morbidity and mortality from the diarrheal disease, especially during the complex emergencies that displace people, such as the ongoing situation in South Sudan, and in the refugee camps themselves.

This research aims to characterize and investigates risk factors, morbidity, and mortality associated with diarrheal disease among CU5 across East African refugee camps. The researcher first conducted a systematic review of the existing literature to identify risk factors, and then followed an empirical characterization of UNHCR data for diarrheal disease in the refugee camps. The dissertation is organized as follows:

- Chapter 2: A systematic review of available literature to address questions about the existing risk factors for diarrheal disease among CU5 in the refugee camps and how they vary across time and space.
- Chapter 3: A characterization morbidity and mortality associated with diarrheal disease in CU5 across East African refugee camps, based on UNHCR-HIS datasets.
- Chapter 4: A cross-sectional analysis of risk factors for incidence of watery diarrheal among CU5 in East African refugee camps in 2016.
- Chapter 5: Implications of research findings

Research Design

In Chapter 2, the researcher conducted a systematic review of the existing risk factors for diarrheal disease in in the refugee camps from 1996 to 2016. The researcher employed the guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) by Moher et al., (2009) to complete the systematic review [18].

In Chapter 3, the researcher used descriptive statistics to analyze secondary data in the characterization of morbidity and mortality associate with diarrheal disease. These data come from 11 years of data in the UNHCR-HIS dataset from 2006 to 2016.

In the final content Chapter 4, the researcher built a, cross-sectional data, based on publicly available 2016 UNHCR data, to examine risk factors for incidence of watery diarrhea among CU5. For Chapter 3-4, the researcher focused on four East African refugee hosting-countries: Ethiopia, Kenya, South Sudan, and Uganda. The UNHCR-HIS case definitions, standards, and indicators were utilized in the analysis. Additional detailed information on research design is included in each chapter.

Data Analysis

Data analysis was conducted using Stata 11.1(StataCorp, College Station, Texas 77845) to compute summary measures, including average mean and frequency of diarrhea morbidity by country and camps; and average means mortality by country. A regression analysis using the Generalized Linear Models (GLMs) was utilized to examine correlations between major risk factors (health service utilization, camp characteristics, and WASH conditions) and the incidence of watery diarrhea in CU5 across East African refugee camps in 2016. Additional detailed information on data analysis is included within each chapter.

CHAPTER 2
A SYSTEMATIC REVIEW OF THE EXISTING RISK FACTORS FOR DIARRHEAL DISEASE IN REFUGEE CAMPS

According to Moher et al., (2009), systematic review "has become increasingly important in health care" (p.e1000097) [18]. In the context of refugee health, one of the justifications for conducting a systematic of health literature includes the intent that organization, such as UNHCR, and their camp implementing agencies, can use this information to improve policies, identification of vulnerable populations within the camp, and access to care in the refugee camps. In addition, in developed countries such as United States (U.S), little research has been conducted among refugees. This is worrisome to the scientific community because many refugees are seeking asylum in developed countries. Therefore, it is time for the developed countries to have a robust understanding of some of the health issues that people in refugee camps face. Furthermore, the world is getting smaller, and in a matter of 24 hours, refugees in African camps can find themselves resettled in other countries bringing with them a lifetime of experiences that determine their health status upon arrival. Such a changing world requires that we better understand refugee health. In doing so, not only do we improve UNHCR and other organizations' ability to improve the situation within camps, but also so that clinicians in the developed world have a better understanding of which health problems refugees coming into the US may have both short and long terms.

Objectives of the Systematic Review

In this chapter, the author conducted a systematic review in an attempt to answer the following question: what are the existing risk factors for diarrheal disease among refugees, and how do these vary across time and space? No protocol for this systematic review existed or was identified during a review of the literature; this was

confirmed through a review in PROSPERO. This systematic review will add to the body of knowledge on diarrheal risk factors and will assist agencies such as UNHCR to strengthen and improve health services and outcomes for these vulnerable populations. In the results, we focus specifically on CU5 living in the refugee camps, due to their increased vulnerability compared to the general population.

Methods for the Systematic Review

The author followed PRISMA guidelines created by Moher and colleagues to conduct the systematic review [18]. To the author's knowledge, no protocol for this systematic review existed in the literature. The author reviewed literature and then searched an International prospective registry of systematic reviews, PROSPERO, and found no record of similar historical undertakings. The PRISMA checklist (included in APPENDIX A) includes the list of items about the article that must be included when conducting and reporting to a systematic review. These include title, abstract, introduction, methods, results, discussion, and disclosure of funding.

Selection Criteria

The following inclusion criteria for selection of articles were used; publication types (they must be scholarly peer-reviewed, journal articles), language (the articles have to be full text in English only), and publication date (Initially the author intended to conduct a systematic review of literature on risk factors from diarrheal disease in the last 10 years (2006 to 2016). However, given the limited focus of this study and the lack of peer review publications on the topic, the range of publication dates included in the review was expanded to include those papers published over a 20 years period from 1996 to 2016. An additional inclusion criteria was the population studied; for this review, the author included publications on populations of refugee living in refugee camps, with

a special focus on CU5. Importantly, another inclusion criterion was risk factors. For a study to be included in our review and analysis, the article ought to include analysis of risk factors for diarrheal disease related to refugee camps. The final inclusion criterion was that the article must pertain to the human species. The outcome inclusion criterion was diarrheal diseases, with attention to populations under five years old, where possible.

The exclusion criteria consists of publications types, language, and publication date. For this systematic review, the author excluded articles that are considered, review articles, personal communications, popular press articles, editorials, letters, comments, working papers, or technical reports. All publications included must be in English; those articles that were not full text in English were not included in this study. Finally, any articles published before 1996 or after 2016 was excluded from this systematic review. Table 2-1 shows inclusion and exclusion criteria.

Summary of Systematic Review Search strategy and Study Selection

Subject headings and truncated, phrase-searched keywords for risk factors for diarrheal diseases and refugee places were searched in 3 major databases widely used in the scientific community: PubMed, Web of Science (WOS), and CABI, on May 24, 2016. Results were combined and limited to English-language full-text, humans, and publications within the last 20 years (1996 to 2016). Full details of the search strategies are given in Appendix B. Study selection was performed by an independent reviewer. Titles and abstracts of the studies identified in PubMed, WOS, and CABI were reviewed. After the abstracts and titles were reviewed, duplicates were removed. When a study relevant to the review was found, the full-text article was retrieved for analysis. Studies that did not meet the inclusion criteria were excluded (Appendix B).

Furthermore, any discrepancies were resolved by the dissertation committee members to double-check the methods.

Data Collection/Extraction

Once relevant articles were identified for the study, data extractions were conducted, and an excel table was created containing the following categories of information for each article: author, year, and title of the article. Also, reference type (i.e., the name of the journal), whether the full article text was online, and what country (s) or region(s) the article studied. Additional information extracted included target population (i.e., universal child, travelers, target adult, high-risk children), study size (total number of people in the study), and actual people that were interviewed out of the total number of people in the study or cases/controls. Moreover, positive cases/negatives, the definition of diarrhea cases (defined or undefined), and the case definition of dysentery cases (defined or not) were extracted from the articles.

In addition, the author gathered data on whether the articles contained control groups (yes or no), analysis of the pathogen Shigella (yes or no), and pathogen *Enterotoxigenic Escherichia Coli* (ETEC) (yes or no).If the article discussed other pathogens than *Shigella* and *ETEC*, the author listed the pathogens.

Most importantly, once all articles identified for inclusion were determined, the author extracted information about statistically not significant risk factors, statistically significant risk factors, and protective risk factors identified in the articles. When possible, the author extracted information about the reason for displacement, such as war or conflict that forces someone to take refuge in the neighboring country. The author also extracted information about the refugee's country of origin (i.e., South Sudanese and Somali who reside in refugee camps in Kenya) and when possible, the

name of the camp of residence (i.e., Kakuma refugee camp). When available in the articles, the author reported the p-value of the associated risk factor and, extracted information about the proportion, prevalence, attack rates, and CFR of diarrheal disease in the article. Finally, the author extracted information about laboratory methods used in the article and the conclusion the author(s) provided in the article.

Quality of the Evidence Using Grades of Recommendation, Assessment, Development, and Evaluation (GRADE)

For this research study, Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) was used to evaluate the overall quality of evidence included in this systematic review [19]. GRADE System “enables more consistent judgments, and communication of such judgment can support better-informed choices in healthcare”(p.1490-4) [19].

Results

A flowchart showing a study selection process is provided in Figure 2-1, including: records identified through database searching, number removed as exact duplicates, records after duplicates removed, total number of abstracts reviewed, number of articles excluded for other reasons, and the total number of articles included in this systematic review. One hundred and twenty-four citations, including 40 duplicates, were found in the PubMed, WOS and CABI databases on May 24, 2016. Evaluation of exact number duplicates removed, records after duplicates removed, and a total number of abstracts reviewed resulted in 84 remaining references; 71 studies did not answer our research question and were excluded for other reasons (i.e., review articles, full text not available or non-English) from our systematic review. In Appendix B the full details of the search strategies for our systematic review are included to explain

why certain studies were excluded. Only 13 studies met all the inclusion criteria and were available for the systematic review analysis of risk factors for diarrheal disease in refugee camps (Table 2-1).

Study Characteristics

Of the 13 studies, most were observational studies, including 3 case-control studies (Table 2-1) [16, 17, 20], 2 prospective cohort studies [21, 22], 3 cross-sectional studies [23-25], 2 descriptive studies [26-28], and 1 retrospective cohort study [29], and only 2 studies were experimental studies [30, 31]. The thirteen articles range in publication date from 1997 to 2015.Table 2-2 describes the characteristics of the thirteen articles included in the systematic review with the following subheadings: author, year, study design, camp, the host country, study population, target population, risk factors, lab methods and diarrheal disease outcome.

In a 1997 case-control study on epidemic cholera in Nyamithuth Refugees Camp in Malawi, most of the refugees residing in this camp originated from Mozambique [20]. 1931 persons were admitted to the treatment tent; there were 50 case patients and 50 matched controls A. In a Case-Control B, the authors collected important data from 47 patients in the treatment tent. Out of the 245 households in Nyamithuthu North, 108 potential control households were then excluded (leaving 137) because one family member had been sick with diarrhea since arriving at the camp. The authors defined Cholera case as “diarrheal illness in a person admitted to an IV treatment tent at Nyamithuthu Camp between 23 August and 15 December 1990” (p.207) [20]. The team interviewed and examined all patients in two IV treatment tents at the *cholera* camp on December 12, 1990 [20]. The risk factors they looked at were as follows: water container, used separate container to drink or wash, shared water container with

neighbors, went to river, drank any river water, left peas out overnight, ran out of firewood in previous week, ate dried fish, owned soap, owned a cooking pot and reheated leftover peas [20].

Peterson et al.,(1998) conducted a prospective cohort study on the effect of soap distribution on diarrhea in Nyamithuthu refugee camp [21]. The authors sample 402 households and survey 356 in mid-March; 322 households were available at the end of the study period. The authors interviewed the subjects twice a week or 4 months about new diarrheal episodes and the presence of soap in the household [21]. Peterson and colleagues defined a New Diarrheal episode "as the onset of diarrhoea (>3 watery stools in 24 h) reported by the female head of the household, in a household that had no diarrheal reported for any household member on the previous two interview days (i.e. diarrheal free for at least one week)" (p.520-524) [21]. The researchers identified the following risk factors in the study: household soap presence, households on days when soap was present, days when soap was not present in the same household, households who had soap in the household on the previous interview day (4 days earlier), number of children age 5, water quantity, maternal education [21]. This study did not use laboratory methods because it was a survey study [21].

Roberts et al., (2001) conducted a randomized intervention trial about keeping water clean in a Malawi refugee camp [30]. They conducted an interview with the household (n=401) with a female head or whomever else may have been available [30]. The researchers visited households twice per week, and they asked if anyone experienced diarrhea [30]. Robert and colleagues (2001) defined diarrhea as "three or more loose stools in a 24-hour period" (p.280-287), and assessed whether the

household had any soap [30]. The following risk factors were identified by the authors in their study: number of huts making up the household, buckets in the household, presence of latrine, animals in the household, visible feces on latrine floor, improve bucket, children had a change of clothes [30]. Regarding laboratory methods used by Roberts et al (2001) they conducted water samples by recording “numbered buckets filled at the wells, the bucket number, the time of filling, the type of bucket, and the sex and approximate age of the water collector” (p. 280-287) [30]. In addition, “water samples were collected in sterilized 125 plastic Nalgene bottles which were placed on ice and analyzed that evening” (p.280-287) [30].

Mourad (2004) conducted a cross-sectional survey of 1,655 households; most of those interviewed were women between the age of 18-49 years [23].This study categorized risk factors by intestinal parasites and diarrhea according to demographic conditions (crowding index, female work, income, age-group-year), intestinal parasites and diarrhea according to environmental health conditions (sewage disposal, barrel, flush-toilet, direct from the tape, indirect from storage tank, full-day water supply, storage tank was cleaned periodically, storage tank was not cleaned, and storage tank was not existing), and intestinal parasites and diarrhea according to hygienic conditions (cleanliness of the house, cleanliness of adults, cleanliness of children, presence of mosquitoes, flies inside the house, house ventilation, garbage inside the house, garbage around the house and status of the kitchen) [23]. It is worth noting that the author did not clearly define diarrhea in his study. This study did not include lab methods.

Doocy and Burnham, (2006) conducted a quasi-experimental study about the point of use water treatment and diarrhea reduction in the emergency context in Monrovia, Liberia [31]. They conducted, a three month study in that included 2215 participants in 400 households [31]. Risk factors that were identified were household size, household head education-years, female (gender), literacy, hand pump, well, narrow opening storage container, covered storage container, removal by dipping, chlorination-ever, and shared or public latrine. Regarding laboratory methods used, the team conducted chlorine coliform, and testing to assess both free and total coliform levels [31].

Abu-Alrub et al., (2008) conducted a prospective cohort study on the prevalence of *Cryptosporidium ssp*. in children with diarrhea in West Bank, Palestine [22]. The researchers examined biological samples from 760 children, sick with diarrhea. Individuals range from 1 month to 15 years of age, and stratified by origin-urban, rural, or refugee camp. Within the sample, 123 children were from refugee camps [22]. In this study, the definition of the diarrhea was not provided, because the focus was the epidemiology of *Cryptosporidium ssp.* Some of the risk factors that were identified included wastewater disposal, rural areas and refugee camps without proper sewage disposal, poor living conditions, and lack of self-awareness, personal hygiene, and cleanliness [22]. Regarding the laboratory analysis, the “stool samples were concentrated using the ethyl acetate sedimentation method and stained by the modified acid-fast stain procedure” (p.059-062) [22].

Abu Elmareen et al., (2008) conducted a descriptive study of isolation and antibiotic susceptibility of *Salmonella* and *Shigella* strains from children in Gaza,

Palestine [32]. They “evaluated a total of 3570 children (and stool samples) age 1 month to 12 years” (p.e330-e333) [32].The authors did not directly define cases of diarrhea, but defined it indirectly, stating “the reasons all children enrolled in [their] study were diarrhea only; diarrhea with vomiting; diarrhea and fever; diarrhea together with vomiting and fever and in some cases, dehydration was present” (p. e-330-e333) [32]. In this article, the authors don’t mention or list any risk factors; however, the author extracted the following assuming they are risk factors: males, females, delay in ordering stool cultures, and patients hospitalization of >3 days [32]. Pertaining to the laboratory methods used by the authors, they “isolated bacteria [and] identified biochemical reaction profile using Hy.enterotest and the API-20E test kit and Antibiotic susceptibility of *Salmonella* and *Shigella* isolates were performed by the disk diffusion method” (p. e-330-e333) [32].

Kerneise et al., (2009) conducted a descriptive study on *Shigella dysenteriae* Type 1 epidemics in refugee settings in Central Africa [27]. They examined an estimated 181,921 cases of *Shigella dysenteriae type 1* among CU5 or old in the refugee camps in Central Africa [27]. The authors defined "dysentery case as any person with diarrhea (passage of 3 or more watery or loose stools in the past 24 hours) and visible blood in the stool" (p.e4494) [27]. Some of the key risk factors identified by the authors were: camp size, children under 5 years old, arrival of refugees, liters of water per person per day, number of residents per latrine, food supply (kcal/person/day), context of settlement, availability of resources and response speed, and seasons (dry and rainy) [27]. Regarding laboratory methods used, the authors

stated that "bacteriological examinations were not routinely available for individual diagnosis and dysentery was diagnosed clinically" (p.e4494) [27].

Shultz et al., (2009) conducted a retrospective matched case-control study on Cholera outbreak among children in four age categories: <2, 2-4, 5-14 and >14 in a Kenyan refugee camp [16]. The authors defined cases as “any person suffering from watery diarrhea (at least three stools in a 24-hour period) who was admitted to the [International Rescue Committee] (IRC) cholera ward from April 1 through June 30, 2005; all patients in IRC’s cholera ward had experienced at least three stools in a 24-hour period” (p.640-645) [16]. The researchers identified the following statistically not significant risk factors: drinking river water, storing water in a jerry can, usually keeps water stored in-house, keeps water stored in house covered, reheat food cooked the previous day, washes hands after eating, washes hands after visiting toilet, washes hands with soap, uses latrine, fifteen or more people sharing the same latrine, and three or more households sharing the same latrine [16]. For laboratory methods used, Shultz et al., (2009) stated that “colonies of growth were evaluated using standard biochemical reactions, and the *Vibrio cholerae* –positive isolates were serogrouped and serotyped using agglutination tests with commercial antisera” (p.640-645) [16].

Hersey et al., (2011) conducted a retrospective cohort study on the incidence and risk factors for malaria, pneumonia, and diarrhea in CU5 in UNHCR refugee camps [11]. The authors stated that “data from 90 UNHCR refugee camps in 16 countries, including morbidity, mortality, health services and refugee health status, were obtained from the UNHCR-HIS from 2006 to 2010” (p.24) [11]. The researchers used the following case definitions for watery and bloody diarrhea: 1.) watery diarrhea was

defined as “diagnosed in persons with diarrhea (passage of 3 or more watery or loose stools in the past 24 hours) with or without dehydration” (p.24) [11], and 2.) bloody diarrhea was defined as “diagnosed in persons with diarrhea (passage of 3 or more watery or loose stools in the past 24 hours) and visible blood in the stool” (p.24) [11]. Risk factors for diarrhea in Hersey et al., (2011) were identified as follows: camp location & size (small <10,000, medium-10,000-19,999 and Large >20,000), water and sanitation (water quantity, water access, water proximity, latrine access, latrine coverage, soap access), nutrition standards (Global Acute Malnutrition (GAM) and rational adequacy) and health service utilization (new visits and growth monitoring) [11]. In this study, authors provided no laboratory methods.

Mahamud et al. (2011) conducted a case-control study on the epidemic cholera in Kakuma refugee camp [17]. The authors identified 224 cases (163 refugees and 61 non-refugees) [17]. The researchers defined a case as “watery diarrhea (>three watery stools in 24 hours) in any resident of Kakuma refugee camp >two years old, who was admitted to the IRC hospital cholera treatment center with the onset of illness after 1 October 2009” (p. 234-241) [17]. Some of the risk factors for cholera identified were: male, Somali, new arrivals after 6/1/09, soap present in the home, used soap to wash hands, latrine in compound, communal latrine, observed feces on ground, neighbor/family member had diarrhea, use water from sources other than tap, dirty water storage containers, treated water before drinking, eat or drink anything outside the home, ate cooked vegetables at home, and drank milk at home [17]. In term of laboratory methods, they used “rectal swabs from patients with diarrhea” (p.234-241) [17].

Mohamed et al., (2014) conducted a cross-sectional survey on health care utilization for acute illness among the refugee population in Nairobi, Kenya [24]. The researchers “collected data from 673 households with 3,005 individuals- an individual was considered a member of a selected household if he/she slept within a compound, apartment, or room within the study area for at least 3 of any of the preceding 12 months” (p.200) [24]. The authors had several standard case definitions at the household level: 1.) Fever “defined as an illness associated with the feeling hot or feverish during the 2 weeks before the interview" (p.200) [24], and 2.) Diarrhea was defined as “three or more loose stools over a 24-hour period during the before the survey" (p.200) [24]. The following risk factors were identified in this study: language predominantly spoken in household (Somali and Oromo), country origin (Somalia and Ethiopia), gender of household member (male and female), age of household member (<5 years and >5 years), caretaker’s education (no school or religious education, religious education, only primary school or less and secondary school or higher), household size (1-<3, 3-<5, 5-<8, and >8), who cared for the person during the illness (no one/cared for self and another family member), social economic status (higher, middle and lower), and severity (severe and mild) [24]. The laboratory methods used were not described by the authors.

Issa et al , (2015) conducted a cross-sectional study on access to safe water and personal hygiene practices in Kulandia refugee camp in Jerusalem [25]. In this study, 96 individuals were enrolled (62 females and 34 males) [25]. The authors defined diarrhea as a “significant elevation in stool movement relative to a subject’s normal bowel habits [25]”. The authors assessed and identified the following risk factors for emesis and

diarrhea: sex (female and male), education level (<8th grade, some or high school graduate, and some or college graduate), annual income-USD (<2000, 2000-3000 and >3000), household water source (piped into dwelling, piped into yard/plot and tanker-truck), drinking water source (piped into dwelling, piped into yard/plot, tanker-truck), parents provided hygiene education**,** received formal hygiene education, and teaching children hygienic practices [25]. In this study, the authors did not describe the laboratory methods they used [25].

In the remaining of this chapter, the author will discuss the non-significant risk factors, statistically risk factors, and protective risk factors for diarrheal disease in studies in the refugee camps.

Synthesis of Systematic Review for Diarrheal Disease Studies in refugee camps

An overview of the Systematic Review synthesis of all the 13 studies can be found in Table 2-3. Major author, year, number of participants, and select statistically significant risk factor, and disease outcome were categorized as headings.

A case-control study by Swerdlow et al., (1997) compared exposures with cholera 50 cases patients with cholera 50 matched controls patients in Case-Controls A [20]. In Cases-Control B, the authors compared 47 case-patients in the IV treatment from households in Nyamithuthu North with 137 controls patient's households selected by going door-to-door in Nyamithuth North (Table 2-3) [20]. For Case-Control A, the researchers found these risk factors: placing hands into the water in the storage container, holding household drinking water during washing or drinking in the previous week, out of firewood during the previous week, and eating cooked pigeon peas that had been left out overnight to be statistically significant(Matched Odds Ratio) (MOR]

=6.0, 95% Confidence Intervals [CI]=1.3-26.8 and [mOR] =8.0, [CI]=1.0-64.0 respectively) [20].

Swerdlow et al., (1997) found these risk factors (drank any river water [mOR]=2.2, [CI]= 0.8-6.3 and placed hands in the water container [mOR]=1.8, CI=0.6-5.5) were not statistically significant risk factors respectively for Case-Control A and Case-Control B [20]. They reported heating leftovers (OR=0.15, CI=0.02-1.0, P<0.05) as a significant protective risk factor [20]

.A prospective cohort study by Peterson et al. (1998), compared diarrhea in households on days when soap was present to days when soap was not present in the same household [21], and found a “27% reduced risk (RR =0.73, 95% CI: 0.54-0.98) (p.520-524). In addition, they found 25% reduction of risk of diarrhea among households (HH) who had soap on the previous interview day (RR = 0.75, 95% CI: 0.51-1.1) (p. 520-524) [21]. In this study, there was no mention of risk factors that were not statistically significant for diarrheal disease.

A study by Roberts et al., (2001) compared households which received improved buckets to households that did not (control houses). Robert et al. found the "presence of animals in the household was significantly associated with increased diarrheal incidence (RR=1.1, P-value=0.003), having animals in the household (RR=1.16, P-value= 0.004) and visible feces on the floor of a household’s latrine (RR=3. 36, P-value =0.001) were significant risk factors for diarrhea” (p.280-287) [30]. Also, Roberts et al. found that households which consumed more water experienced less diarrhea (P <0.01, and they found that “among children up to 5 years of age, having an improved bucket (RR=0.57, P-value=0.040), a latrine (RR=0.86, P-value=0.188), a change of clothing (RR=0.67 P-

value=0.078) and more buckets in household (RR=0.86, P-value=0.22) were protective against diarrhoea"(p.280-287) [30].

A cross-sectional survey by Mourad et al., (2004) compared "socioeconomic-demographic, environmental health and hygiene conditions associated with intestinal parasites and diarrhea" (p.131-142) [23]. Mourad et al.,(2004) found children aged younger than one year to be statistically significant risk factors for diarrheal disease [23]. The authors did not mention non-statistically significant risk factors for diarrheal disease, or any protective risk factors for diarrheal disease.

A quasi-experimental study by Doocy and Burnham (2006) compared "diarrhea rates among households with flocculants–disinfectant water treatment and improved water storage (intervention group) to households with only improved storage (control group)" (p.1542-1552) [31]. Doocy and Burnham (2006) found "Diarrhoea prevalence and incidence were significantly greater in Last Displaced Camp than in Morris Farm (P < 0.001 for both comparisons)" (p.1542-1552) [31]. In addition," significant difference in rate of contamination between the two sites was observed with Last Displaced Camp and Morris Farm reporting contamination in 88% and 86% of water source tests, respectively (P = 0.959) and no significant levels of free or total chlorine were observed in any water source during any time in the trial" (p.1542-1552) [31]. Finally, this article did not identify the protective factors for the presence of diarrhea in each household member.

A prospective cohort study by Abu-Alrub et al., (2008) compared children with diarrhea to children without diarrhea (matched control) among Palestinian children living in the West Bank [22]. The researchers found that children younger than 5 years of age

(14.4%), children 5 to 10 years old (7.7%) and children of 11 to 15 years of age (5.9%) to be statistically significant risk factors (P<0.05) for cryptosporidium spp. infection among Palestinian children with diarrhea living in West Bank [22]. In this study, there were no protective risk factors that were identified by the authors.

A descriptive study by Abu Elamreen et al., (2008) compared children with diarrhea only to diarrhea with vomiting to diarrhea and fever to diarrhea with vomiting and fever [32]. They not identify or analyse risk or protective factors for the presence of Salmonella and *Shigella*.

A descriptive study by Kerneis et al., (2009) "compared some cases of bloody diarrhea and deaths in refugee's camp to persons five years or older" (two age groups: children under five years' vs. persons five years or older) (p.e4494) [27]. The authors did not report their summary measures in statistical comparisons but reported “CFR were higher in children under 5 with the highest CFR seen in Inera (18.3%) and lowest CFR (1.6%) in Rukondo” (p.e4494) [27].

A retrospective Matched Case-Control Study by Shultz et al.,(2009) compared cases of cholera with matched controls during an outbreak [16]. Two of the risk factors for cholera identified by Shultz et al. were “sharing a latrine with three or more households (Matched Odd Ratio –MOR = 2.17 [1.01, 4.68]), and having recently arrived to the camp (MOR = 4.66 [1.35, 16.05]) [16]. The study identified water sources being used including communal taps, wells, water from vendors, rainwater, and bottled water, but none of these was found to be statistically significantly associated with having been ill with cholera [16]. Key protective factors identified were; “storing water in the

home in sealed or covered containers tended to be protective (MOR = 0.55 [0.29, 1.03])" (p. 640-645) [16] .

Hersey et al., (2011) compared risk factors for malaria, pneumonia, and diarrhea in children 5 years old in UNHCR Refugees Camps [11]. The authors found that: camps in Asia were more likely to have cases of diarrheal disease than those in Africa (Incidence Rate Ration (IRR)= 1.93, 95% CI 1.52-2.45), camps with large (≥20,000 refuges) and medium (10,000-19,999 refugees) size populations were associated with increased patient visits for diarrhea (IRR= 2.16, 95% CI 1.04-4.49 and IRR = 1.80, 95% CI 1.07-3.03, respectively) compared to small (< 10,000 persons) camps, and increased new patient visits was associated with an increase in all patient visits for diarrhea (IRR= 1.90, 95% CI 1.38-2.62) [11]. No protective factors for malaria, pneumonia, and diarrhea were identified in the study.

A case-control by Mahamud et al., (2011) compared cases during cholera outbreak to Matched Control of in Kakuma refugee camp [17]. They found dirty water storage containers to be a statistically significant risk factor, non-significant risk factors were not found, and protective factors found were: those who ate cooked vegetables, drank milk at home, and "treating water by either boiling it or treating it with chlorine before drinking" (p.24) [17].

A cross-sectional study by Mohamed et al., (2014) compared Febrile illness, Acute Respiratory Infection (ARI), and diarrhea in an urban refugee camp [24].The also authors found "non-Kenyans in the middle SES group were significantly more likely to seek health care services (OR 3.04; 95% CI 1.39-6.63; p = 0.005)" (p.200) [24]. The authors found that "three variables (P<0.1) were significantly associated with health

care seeking behavior: recommendation by a third party to seek health care services, father's origin in Ethiopia and being in the middle SES category" (p.200) [24]. The researchers did not describe any protective risk factors for ARI and diarrheal illness.

A cross-sectional study compared womens' education to mens', water source piped in dwelling to water tanker-truck, for individual and household Gastro-intestinal (GI) burden (emesis and diarrhea) [25].The study found that compared to men, women had statistically significantly better hygiene practices and lower GI burden and diarrhea [25]. The authors found an statistically significant association between formal, higher education, and emesis ($P<0.05$), and diarrheal ($P<0.05$), piped drinking and household water and less diarrhea ($P<0.05$), soap availability ($P<0.05$), hand wash post restroom use, hand wash before meal preparations, and vender cleanness consideration, and lower GI burden [25].

Quality of the GRADE

This systematic review includes GRADE of the risk factors for diarrheal disease in refugee camps, illustrating the overall quality of the evidence (Table 2-4). The quality of evidence in this analysis are categorized as being either very low, low or high. Very low is defined as "any estimate of effect is very uncertain" (p.1490-4) [20]. Low is defined as "Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate" (p.1490-4) [19]. High is defined as "further research is unlikely to change our confidence in the estimate of effect" (p.1490-4) [19].

Most studies included were observational studies (i.e., cohort, cross-sectional, and case-control), which resulted in very low, and low levels according to GRADE [19].

In Table 2-4, 54% of articles (7/13) were low-level evidence, 38% of the articles (5/13) were ‘very low evidence, and 7.69 % of the articles (1/13) were high-level evidence.

In the thirteen articles studied, a risk of bias was found due to the limitation of the study designs. The case-control study by Swerdlow et al., (1997) has a major problem with confounding variables and bias (i.e., sampling bias, observation bias, and recall bias) [33]. For example, 50 patients with cholera in Nyamthuthu camp, Mali, may be a biased sample (for example cholera patients being referred from outside of Nyamithuthu camp) or the 50 matched cholera patients may be biased due to whether these controls were volunteers, different ages, sex and socioeconomic group in the Nyamithuthu Camp [33].

A potential issue in the cross-sectional survey by Mourad et al., (2004) is that it cannot differentiate cause and effect from simple association [33]. For example, it is difficult to establish cause and effects of socioeconomic-demographic, environmental health and hygiene conditions associated with intestinal parasites and diarrhea.[33].

Summary of Findings

In summary, the most risk factors for diarrheal diseases in refugee camps involved WASH conditions. The statistically significant risk factors identified in the systematic review associated with an increase of diarrheal disease in the refugee camps were:

- Placing hands into of a household water storage container;
- Holding household drinking water during washing;
- Household not having firewood during the previous week;
- Eating leftover that had been left out overnight;
- Presence of animals within the household;

- Visible feces on the floor of a household's latrine;
- Children age younger than one year;
- Sharing a latrine with three or more households;
- Being a recent arrival in refugee camp;
- The presence of dirty storage containers for water;

Protective risk factors identified in this systematic review against diarrheal disease in the refugee camps were:

- Heating leftovers;
- The presence of soap in a household;
- Having an improved bucket;
- Presence of an improved latrine;
- Having a change of clothing;
- Having more buckets in household;
- Storing water in the home in sealed or covered container;
- Consuming cooked vegetables;
- Drinking milk at home; and
- Treating water by either boiling it or with chlorine before drinking.

Key finding of this systematic review is that most of the diarrhea diseases in refugee camps that are reported within the literature are in the form of the outbreaks. The diarrheal pathogens reported in this systematic review are, *Cholera*, *Enterobius*, *vermicular*, *Giardia lamblia*, *Entamoeba*, *Histolytica, Cryptosporidium*, *Salmonella*, *Shigella*, and *Emesis*.

For this review, risk factors for diarrheal disease in refugee camps were searched as key subject headings. The 3 major databases searched were PubMed,

WOS, and CABI. The results were combined and then limited to English-language full-text, humans subjects, and publications within the last 20 years (1996 to 2016). Full details of the search strategies are given in the appendix (Appendix A). Study selection was performed by an independent reviewer. Titles and abstracts were reviewed and duplicates removed. The full-text of relevant studies was then retrieved for analysis, and studies that did not fully meet the inclusion and exclusion criteria were excluded.

This study aimed to conduct a systematic review of existing risk factors of diarrheal disease in the refugee camps. Conducting a systematic review, the author followed (PRISMA) guidelines, and used GRADE to assess the quality of evidence by [19]. In this review, most of the studies (7/13) were observational, and the rest of (6/13) were experimental (1), quasiexperimental (1), and descriptive (4).

Limitations of the systematic review. There are several limitations in this systematic review. By focusing on the scholarly literature, this search does not include the grey literature, which is a very common outlet for humanitarian and development work. In addition, the population we are focusing on is refugees. Most of them reside in sub-Saharan Africa, and this population is not well studied due to the harsh environmental conditions they live in, and the magnitude of severity of the situation many of them find themselves in. Research in the context of humanitarian disaster or complex emergencies is logistically complicated, thus there is very limited data. This is underscored by the scarcity of evidence on the subject of diarrheal disease among refugees: from one hundred-twenty four potentially relevant studies, only 13 studies met the review selection criteria. Furthermore, these studies show large scale heterogeneity in all risk factors across the refugee camps, populations, and diarrheal disease in these

settings. The final limitation is that the quality of the evidence available from the 13 studies in this review was very low.

Table 2-1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Publication type	Publication type
Language	Language
Publication date	Publication date
Population studied	
Risk Factors	
Human subject focus	

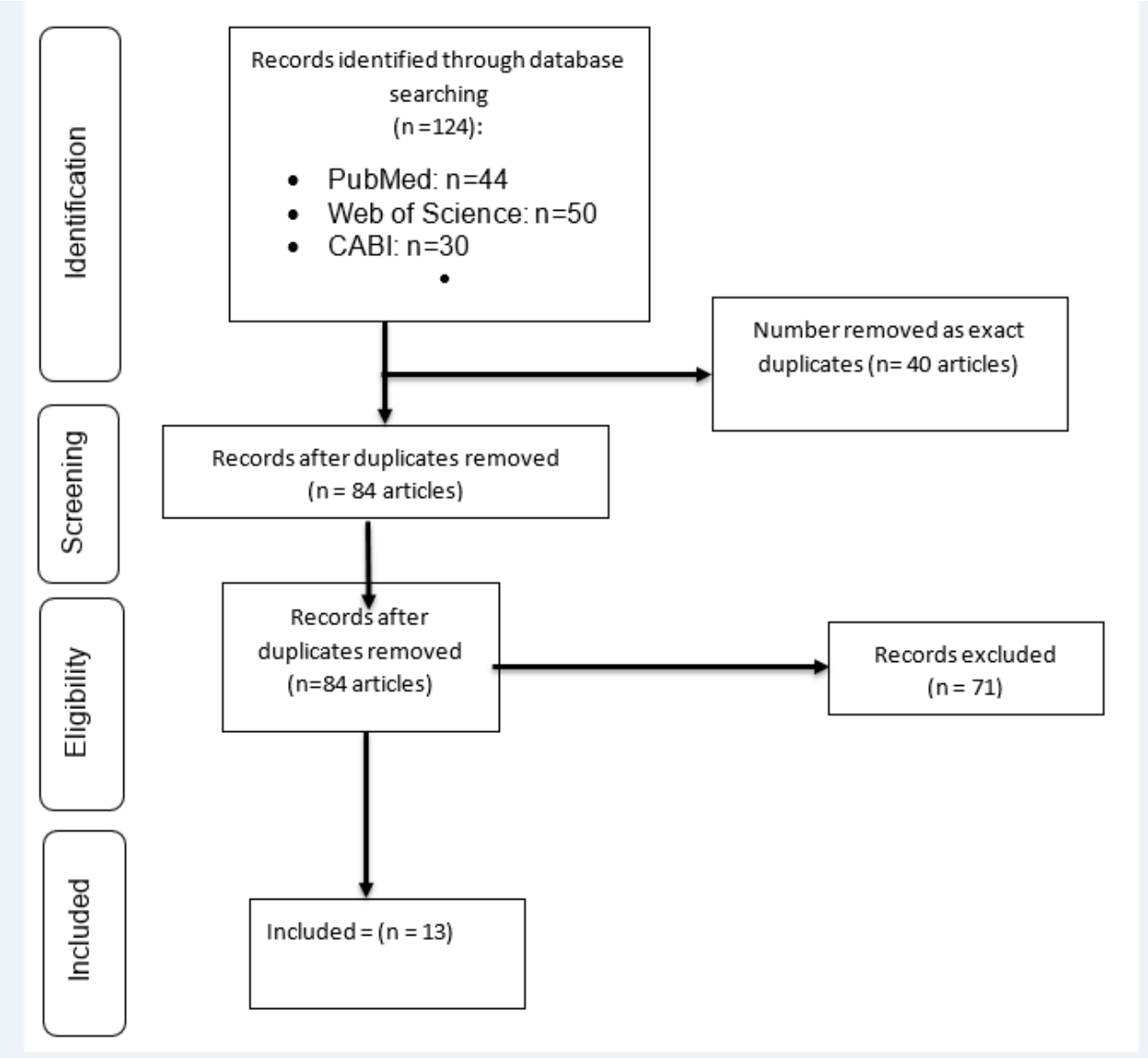

Figure 2-1.Flowchart of identification and selection of studies for systematic review of risk factors for diarrheal disease in the refugee camps: 1996-2016

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Table 2-2. Characteristics of the 13 articles included in the Systematic Review for existing risk factors for Diarrheal Disease in the refugee camps from 1996-2016.

Author, Year	Study Design	Camp, Host Country	Country of Origin	Study Population	Target population	Selected Risk Factors	Lab Methods	Outcome
Swerdlow et al.1997	Case-Control	Nyamithuthu, Malawi	Mozambican	1931 of the 6114 persons admitted to the IV treatment tent	Age-group: 0-4 years, 5-14 years and >15 years old.	Drinking river water, place hands into stored household drinking water and eating leftover cooked peas.	“Rectal swabs of patients” and Use standard DPD reagent and cultured with the Spira jar technique	Cholera
Peterson et al. 1998	Prospective Cohort	Nyamithuthu, Malawi	Mozambican	402 households surveyed and then interviewed.	Age-group:<5 years, 5-14 years and 15+ years.	Presence of soap in the household (protective factor).	N/A: No Lab methods provided, it was Survey	New diarrhea episode
Roberts et al. 2001	Experimental	Nyamithuthu Malawi	Mozambican	401 Mozambican refugee households followed over a 4-month	Children <5 years of age	Visible feces in the family latrine and the presence of animals.	Water Samples	Diarrhoea

Table 2-2. Continued

Author, Year	Study Design	Camp, Host Country	Country of Origin	Study Population	Target population	Selected Risk Factors	Lab Methods	Outcome
T.A. Abu Mourad. 2004	cross-sectional	Nuseirat, Gaza Strip	Palestinian	1625 households Survey.	Age-groups: <1 <1-4 <Boys and girls aged>9 18-33 years 34-49 years >50 years	Crowding, the source of drinking, water and the cleaning of water tanks.	N/A: No Lab methods provided, it was Survey.	Enterobius vermicularis, Giardia lamblia, Entamoeba histolytica, Ascaris lumbricoides, Giardia lamblia and Enterobius vermicularis, Entamoeba histolytica and Giardia lamblia
Shannon Doocy and Gilbert Burnham. 2006	Quasi-experiment	IDPs, Liberia	Liberians	A total of 2215 participants.	Children less than 5 years of age	Flocculant-disinfectant	Chlorine and coliform testing	Diarrhea

Table 2-2. Continued

Author, Year	Study Design	Camp, Host Country	Country of Origin	Study Population	Target population	Selected Risk Factors	Lab Methods	Outcome
Sameer M. Abu-Alrub et al. 2008	Prospective Cohort	West Bank (Urban centers, rural villages, refugee camps), Palestine	Palestine	Fecal samples were taken from 760 with diarrhea	Age group: 1 month to 13 years old.	Age group <5 years	"The stool samples were concentrated using the ethyl acetate sedimentation method and stained by the modified acid-fast stain procedure"	Cryptosporidium spp
Abu Elamreen et al. 2008	Descriptive	ElNasser pediatric hospital, Gaza, Palestine	Palestine	Evaluated 3570 stool specimen: All stool samples were examined for the presence of *Salmonella* and *Shigella*	Patients ranged in age from 1 month to 12 years	N/A: this article does not mention or list any significant risk factors.	"Isolated bacteria were identified by their biochemical reaction profile using Hy.enterotest and the API-20E test kit".	*Salmonella* and *Shigella*

Table 2-2. Continued

Author, Year	Study Design	Camp, Host Country	Country of Origin	Study Population	Target population	Selected Risk Factors	Lab Methods	Outcome
Kerneis et al. 2009	Descriptive	11 refugee camps:	Rwandans	181,921 cases of bloody diarrhea was reported	Children Under Five years old	Children Under Five, small and medium and large camps.	“Dysentery was diagnosed clinically”.	Shigella dysenteriae Type 1
Shultz et al. 2009	Retrospective Matched Case-control	Kakuma, Kenya	South Sudanese and Somalia.	418 people treated	Four age categories: < 2, 2-4, 5-14 and >14).	Sharing a latrine with at least three households and arriving at Kakuma camp on or after November 2004.	V.cholerae serogroup 01 isolated from stool	Cholera outbreak
Hersey et al. 2011	A retrospective Cohort	90 UNHCR Camps, 16 countries	16 countries	Under five (U5) population mean =3812 (Africa) 1761 (Asia).	Children Under Five Years Old (CU5) Years.	Camp characteristics in Africa and Asia, Health facility visits, and growth monitoring.	N/A	Diarrhea

Table 2-2. Continued

Author, Year	Study Design	Camp, Host Country	Country of Origin	Study Population	Target population	Selected Risk Factors	Lab Methods	Outcome
Mahamud et al. 2012	Case-Control	Kakuma, Kenya	Somali, South Sudanese, and Ethiopians.	Total 224 cases were identified and hospitalized at IRC Hospital.	Age groups: <5, 5-14-, 15-24 and >25	Presence of dirty water storage containers.	V.Cholerae 01, serotype Inaba isolated in the stool specimens.	Cholera outbreak.
Mohamed et al. 2014	Cross-sectional	Eastleigh, Kenya	Somalia, Ethiopia, and Eritrea.	Collected 673 households with 3, 005 individuals.	Age groups: <20 years old, 20-35 years old.	Care seeking behavior, reasons for not seeking care.	N/A	Healthcare Utilization of illness (i.e diarrhea).
Issa et al. 2015	Cross-sectional	Kulandia refugee camp, Jerusalem, Israel.	Palestine	96 individuals enrolled in the study; 62 females and 34 males.	Sex: Male and Female	Sex, parents provide hygiene education, receive formal hygiene.	N/A	Diarrhea and Emesis

Table 2-3. Synthesis of the findings of the Systematic Review of risks factors of the diarrheal in refugees camps from 1996-2016.

Author, Year	#Participants	Statistically significant risk factor	Protective factor	Selected Comparison	Outcome (Diarrheal Disease)
Swerdlow et al. 1997	50 case patients and 50 matched controls.	The previous week, eating cooked pigeon peas that had been left out overnight (mOR=8.0, CI=1.0-64.0).	"Heating leftover peas was protective: OR=0.15 (CI=0.02-1.0).	Exposures case patients Versus Matched Controls Patients.	Cholera.
Peterson et al.1998	168 households with children under 5 of mothers reported washing their children's hands.	27% reduced risk (RR =0.73 CI 0.54-0.98) of diarrhea in households on days when soap present vs days when soap was not.	"Soap in a household, there were 27% fewer episodes of diarrhea in households when soap was present compared to when no soap".	Diarrhoea in households on days when soap was present versus Days when soap was not present.	New Diarrhoea Episode:
Roberts et al. 2001	"310 study participants received improved buckets and "850 individuals in control households remained throughout the study".	"Having animals in the household (RR=1.16, P-value= 0.004) and visible feces on the floor of a household's latrine (RR=3. 36, P-value =0.001) were significant risk factors for diarrhea"	"Among children up to 5 years of age, having an improved bucket (RR=0.57, P-value=0.040) , a latrine (RR=0.86, P-value=0.188), a change of clothing (RR=0.67 P-value=0.078) and more buckets in household (RR=0.86, P-value=0.22) were protective against diarrhoea"	Households identified to receive the improved buckets versus controls houses.	Diarrhoea:

Table 2-3. Continued

Author, Year	#Participants	Statistically significant risk factor	Protective factor	Selected Comparison	Outcome (Diarrheal Disease)
T.A. Mourad,2004	A total of 485/1625 of the investigated households reported parasitic cases.	"Highest prevalence of diarrhea was found to be statistically significantly higher among children aged younger than one year (X^2=554, P<0.0001)."	Not available (N/A)	Yes/No question versus multiple choice	Enterobius vermicularis, Giardia lamblia, Entamoeba histolytica and Ascaris lumbricoides.
Doocy and Burnham, 2006	"Total of 200 households in each intervention group with 1138 and 1053 individual participants".	"Diarrhoea among control Vs. Intervention households for diarrhea incidence and prevalence were 3.0(CI 2.7–3.3) and 4.4 (CI 4.0–4.8).	Not available (N/A)	"Diarrhoea rates households vs. improved water storage households (control groups)".	Presence of Diarrhea.
Abu-Alrub et al. 2008	"Fecal samples were taken from 760 children with diarrhea"	"Prevalence rate of cryptosporidiosis was found in children younger than 5 years' age (14.4%) as compared to that in children 5 to 10 years old (7.7%) and in children 11 to 15 years of age (5. 9%)".	Not available (N/A)	"Children with diarrhea (one month to 15 years old) Versus Matched Controls and treated exactly in the same manner as the other specimens".	Cryptosporidium spp.

Table 2-3. Continued

Author, Year	#Participants	Statistically significant risk factor	Protective factor	Selected Comparison	Outcome (Diarrheal Disease)
Abu Elamreen et al. ,2008	Evaluated 3570 (children) stool specimens of patients ranged in age from 1 month to 12 years.	Not available (N/A)	Not available (N/A)	Compare children enrolled in this study based on: Diarrhea only versus diarrhea with vomiting versus diarrhea and fever and diarrhea with vomiting and fever!	Salmonella and Shigella
Kerneis et al. 2009	Small camp ranged from 8,588 to 215,889 in the largest camp.	CU5 has highest CFR in Inera (18.3%) and lowest (1.6%) in Rkondo.	Not available (N/A)	Children under five years vs persons five years or older.	*Shigella dysenteriae Type 1*:
Shultz et al. 2009	348 cases in camp residents were enrolled along with 170 matched controls.	"Sharing a latrine with three or more households (MOR = 2.17 [1.01, 4.68]) and being a recent arrival in the camp (MOR = 4.66 [1.35, 16.05]) were associated with increased risk for disease".	"Keeping water stored in home sealed/ covered was protective (MOR = 0.49 [0.25, 0.96])".	Cases with Cholera Outbreak Versus Matched Control of Cholera outbreak.	Cholera Outbreak
Hersey et al. 2011	"UNHCR had more refugee camps in Africa than Asia, 117 camp-years were analyzed for Africa and 36 for Asia".	Camps in Asia were more likely to have cases of diarrheal disease than those in Africa (IRR= 1.93, CI 1.52-2.45)".	Not available (N/A)	Comparison of risk factors for malaria, pneumonia, and diarrhea in children 5 years old in UNHCR Refugee Camps.	Malaria, Pneumonia, and diarrhea.

Table 2-3. Continued

Author, Year	#Participants	Statistically significant risk factor	Protective factor	Selected Comparison	Outcome (Diarrheal Disease)
Mahamud et al. 2012	“A total of 93 cases and 93 matched controls were enrolled into the study”.	“presence of dirty water storage containers, which was a risk factor (AOR 4.39, CI 1.12-17.14, p = 0.034)”	“Washing hands with soap, which was protective against cholera (Adjusted OR [AOR] 0.25, CI 0.09-0.71, p = 0.010)	Cases with Cholera Outbreak Versus Matched Control of Cholera outbreak in Kakuma refugee camp.	Cholera
Mohamed et al. 2014	3,005 participants. Reported at least one of the illness of interest (ARI and Diarrhea).	“Non-Kenyans (seek health care services: OR 3.04; CI 1.39-6.63; p = 0.005)”.	Not available (N/A)	“Children under the age of 5 years versus persons older than 5 years”.	Acute illnesses: ARI and Diarrhea.

Table 2-3. Continued

Author, Year	#Participants	Statistically significant risk factor	Protective factor	Selected Comparison	Outcome (Diarrheal Disease)
Issa et al. 2015	“A total of 96 individuals were enrolled in the study; 62 females and 34 males”.	“Having soap available at each sink is associated with fewer diarrhea episodes (P<0.05; 31.6% for yes, 55.6% for sometimes, 83.3% for no associated with 2 or more diarrhea episodes”.	“Formal, higher education appeared to be protective against emesis (P<0.05) and diarrheal symptoms (P<0.05)”.	Women educate compared with men. Women more likely to have better hygiene practices with lower GI burden emesis and diarrhea Versus relative to men. Water source piped in dwelling versus for tanker-truck	Emesis and diarrhea.

Table 2-4. Grades of Recommendation Assessment, Development, and Evaluation (GRADE) for Systematic Review of the risk factors for diarrheal disease in refugee camps from 1996-2016.

Author, Year	Study Design	Assigning GRADE of Evidence	Definitions of GRADE of Evidence by[19]
Swerdlow et al. 1997	Case-Control Study	Low	Low: “Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate”[19]
Peterson et al. 1998	Prospective Cohort Study	Low	See definition[19]
Roberts et al. 2001	Experimental Study (Randomized trial Intervention Trial)	High	High: “further research is unlikely to change our confidence in the estimate of effect”[19]
Mourad,2004	A cross-sectional Survey	Very low	Very Low: “any estimate of effect is very uncertain”[19]
Doocy and Burnham, 2006	Quasi-experiment study	Very low	See above definition
Abu-Alrub et al. 2008	Prospective Cohort Study	Low	See definition above
Abu Elamreen et al. ,2008	Descriptive Study	Very low	See definition above
Kerneis et al., 2009	Descriptive Study	Very low	See definition above
Shultz et al. 2009	Retrospective Matched Case-control study	Low	See definition above
Hersey et al. 2011	A Retrospective Cohort Study	Low	See definition above
Mahamud et al. 2012	Case-Control Study	Low	See definition above

Table 2-4. Continued

Author, Year	Study Design	Assigning GRADE of Evidence	Definitions of GRADE of Evidence by[25]
Mohamed et al. 2014	Descriptive Study	Very low	See definition above
Issa et al. 2015	Cross-sectional Study	Low	See definition above

CHAPTER 3
CHARACTERIZATION OF DIARRHEA MORBIDITY, AND MORTALITY AMONG CHILDREN UNDER FIVE (CU5) ACROSS EAST AFRICAN REFUGEE CAMPS

Background

Global Burden of Diarrheal Disease

Worldwide, diarrheal disease is the third leading cause of morbidity and mortality in CU5: 7.6 million children are estimated to die every year from diarrheal diseases [8]. Globally, the majority of children who die from diarrheal diseases reside in developing countries in sub-Saharan Africa and South Asia [8]. A study by Kosek et al,.(2003) found diarrheal morbidity incidence for CU5 is 3.2 episodes per child per year, and that 21% of deaths among CU5 were attributable to diarrhea [34]. Black et al,.(2003) pointed out that "ingestion of unsafe water, inadequate availability of water for hygiene, and lack of access to sanitation contribute to about 1.5 million child deaths and 88% of deaths from diarrhea" (p.2226-2234) [35].

A study examining incidence and risks factors for diarrhea in CU5 in UNHCR camps found that 7% of mortality and 10% of morbidity among CU5 were attributable to diarrheal diseases [11]. A study by Cronin et al. (2009) *quantifying the burden of disease associated with inadequate provision of water and sanitation in selected sub-Saharan refugee camps* found that in Ethiopia, the average per capita Disability-Adjusted Life Years (DALY) due to diarrhea [was] higher than the national averages, and yet the number of deaths due to diarrhea in the camps was much lower than the national average [36]. Cronin et al., (2008) have documented that GAM rates among CU5 ranged between 18 and 23%, and those with the highest risk for GAM were those children with dysentery in the camps [37]. A study in Western Kenya found that the 2-week period prevalence of diarrhea among all children was 26% [38].

Registered Refugees-Asylum-Seekers in East Africa in 2017

It has been documented that there is a lack of adequate water and sanitation in the following refugee-hosting countries: Uganda, Chad, Kenya, and DRC [37]. Because diarrheal disease is ubiquitous among refugees, these vulnerable populations mainly rely on: adequate quantities of disinfected water, elementary sanitation, community outreach, and managing cases of the patients when they are sick [37].

Table 3-1. shows registered refugees and asylum-seekers across East African refugee camps. The total registered refugees-asylum-seekers in Ethiopia in 2017 was 829,925, the proportion of CU5 was 14% (Female -7.0% and Male 7.1%), and Country of Origin of refugees included: South Sudan, Somali, Eritrea, Sudan, Yemen and other nations (Table 3-1) [39]. In 2017, the total registered refugee population in Kenya was 488,045, 15.3% CU5 refugee came from Somalia, South Sudan, DRC, Ethiopia, and Sudan [40].

For South Sudan, in 2017, the total number of registered refugees was 268,286, 20% CU5, and the country of origin for refugees were Sudan, DRC, Ethiopia, and CAR [41]. For Uganda in 2017, the total number of refugees and asylum-seekers was 1,252,470, and the country of origin of refugees were primarily South Sudan, DRC, Burundi, Somalia, Rwanda and others (Table 3-1) [42].

Vulnerability of Refugee Populations

Refugee populations constitute vulnerable groups of people globally, for various and complex reasons. In Africa, refugee camps are located mostly in rural areas and service populations affected by long-running conflicts or aftermath of emergencies. UNHCR routinely monitors many of the variables widely accepted as risk factors for diarrheal disease, including access to health care services, nutritional status of children,

access to water, and WASH conditions [11]. However, the difficult, yet typical conditions of refugee camps additionally exacerbate conditions, e.g., overcrowding, a lack of access to clean water and sanitation, and inadequate shelter [11]. All of these factors may increase the risk of diarrheal infections among refugees, particularly among the most vulnerable population, CU5.

UNHCR and HIS

In 1950, the office of the UNHCR was established, and today, it is the lead agency "protecting and assisting refugees around the world" [43]. Currently, there are 65.6 million forcibly displaced people worldwide, and 22.5 million are refugees [44]. The proportion of displaced people hosted by continent, from highest to lowest is as follows: Africa (30%), Middle East and North Africa (26%), Europe (17%), the Americas (16%), and Asia and Pacific (11%) [44]. It is documented that 55% of refugees globally came from the following three countries: Syria (5.5 million), Afghanistan (2.5 million) and South Sudan (1.4 million) [44].

In 2006, the UNHCR launched HIS and currently, HIS is operational in Ethiopia, Kenya, Uganda, South Sudan and other countries. The HIS is “designed to monitor the health status of the refugee population and to increase the early detection of an adequate response to outbreaks” [45]. HIS data are collected weekly and entered monthly into the HIS reporting system. These data provide important insights into the health of refugee populations globally.

The HIS data provide a unique opportunity to characterize diarrheal morbidity-mortality. Understanding these data may assist implementing agencies to better plan how to prevent diarrheal disease morbidity and mortality among CU5 within a context of limited resources. Thus, the overall goal of this research is to characterize diarrheal

morbidity and mortality among CU5 in East African refugee camps, using the UNHCR-HIS data from 2006-2016. This study will help us to have a better understanding of the burden of diarrheal disease in CU5, which may be applicable in refugee camps across other parts of the world.

Aims of the Research

For this chapter 3, specific research aims include:

Aim 1: To describe the geographic distribution of camp level data included in UNHCR Diarrhea Morbidity, Mortality, and WASH-Nutrition datasets form 2006-2016.

Aim 2: To characterize diarrheal morbidity and mortality among CU5 across East African refugee camps.

The remaining sections of this paper are laid out as follows: First, a description of the three HIS datasets utilized in this research and methods used to generate results are described. Next, results including a section on morbidity and one on mortality are examined. Finally, implications of these findings are discussed.

Methods

UNHCR provided HIS data access to researchers at the University of Florida to answer questions surrounding Health Facility Utilization (HFU) rate (consultation/person/month), the incidence of watery (cases/1000/population/month) and incidence rate of bloody (cases/1000/population/month) with diarrheal disease among CU5 in refugee camps in East Africa. Three separate datasets entitled *Diarrhea Data*, *Pop-Mort data***,** and *WASH-Nutrition Data* were provided in the form of excel spreadsheets. The 3 datasets were cleaned and imported into Stata 11.1 (StataCorp LP, College Station, Texas, USA) for analysis.

Data

HIS Diarrhea Dataset

Like all HIS data, diarrhea data are collected on a monthly basis at refugee camps across East Africa, including those in Ethiopia, Kenya, South Sudan, and Uganda. The key variables existing within the HIS, dataset and of interest to this project were the HFU rate, the incidence of watery diarrhea, and incidence of bloody diarrhea, among CU5. The researcher collapsed (pooled mean) of HFU rate, incidence of watery diarrhea, and incidence of bloody diarrheal by country and month. Also for camp level analysis, the researcher collapsed the same variables mentioned above by year, country and camp. These data were included in analyses comprised data from 39 camps between 2006 and 2016.

HIS Population Mortality Dataset

Within the second data set, which contained important diarrhea-related mortality data, information was included for 59 refugee camps across the four study countries. This included mortality data in cases of watery and cases of bloody diarrhea, as well as cases of acute malnutrition among CU5 between 2006 and 2016. Similar to the diarrheal data in the first dataset, the data reported in the mortality dataset is collected monthly at camps across East Africa before being sent to UNHCR headquarters. Specifically, the HIS mortality dataset provided the following variables included in the analysis: sex-disaggregated mortality cases of watery diarrhea in CU5, sex-disaggregated mortality cases of bloody diarrhea in CU5 , and sex-disaggregated mortality cases of acute malnutrition in CU5.

Water and Sanitation & Hygiene (WASH)-Nutrition Dataset

The third and final dataset, which included water, sanitation, and hygiene-nutrition data, differed markedly from the Diarrhea and Mortality datasets. These data are collected through an annual survey conducted by UNHCR across the East Africans refugee camps. The following variables were of interest for this analysis: average number of liters of potable water available per person per day, percent of families with latrines, percent of families receiving >250g soap, percent of households collecting at least 15 liters of water per day, percent of water quality tests meeting necessary standards, and prevalence of GAM.

Case Definitions and Standards

UNHCR HIS case definitions and UNHCR standards and indicators were used for much of this analysis. Throughout this chapter, the following definitions have been used: 1.) HFU-rate is defined as number of new out-patient consultations per person per month [46]; 2.) incidence rate is defined as the new cases due to diarrheal disease per 1000 persons per month [46] ;3.) watery diarrhea is defined as persons with diarrhea (passage of 3 or more watery or loose stools in the past 24 hours) with or without dehydration [47], 4.) bloody diarrhea is defined as person with diarrhoea (passage of 3 or more watery or loose stools in the past 24 hours) and visible blood in the stool [48]; 5.) number of children under five years of age is defined as the number at mid-month of all CU5 from a defined geographic location (can be disaggregated by sex for male/female) [46]; 6.) Under 5 mortality rate (UMR) is defined as the number of deaths during the month among children <5 years of age per 1,000 population per month [46]; 7) acute moderate malnutrition is defined as children with a weight for height index of <-2 and >-3 z-scores [48].

Data Management and Analysis

Data were examined for duplication, and the duplicates were dropped. Camps data were stratified into four geographic areas of interest for the remainder of the analysis: Ethiopia, Kenya, South Sudan, and Uganda. Characteristics of East African refugee camps were compared across countries. Categorical variables are shown in percentage, and continuous variables are shown as means. Water, sanitation, and nutrition variables were converted into dichotomous variables based on the performance of meeting or failing to meet UNHCR standards [11].

Data analysis was conducted in Stata 11.1 and included summary measures of the diarrhea morbidity variables, diarrhea population mortality data variables, and WASH-nutrition variables. Among camps included in the Diarrhea dataset (n=39; Ethiopia n=15, Kenya n=7, South Sudan n=6, and Uganda n=11), the following variables were examined: incidence rates of watery diarrheal in CU5, the incidence rate of bloody diarrhea cases in CU5, and HFU rate. Among camps included in the Mortality dataset (n=59; Ethiopia n=28, Kenya n=7, South Sudan n=12, and Uganda n=12) variables examined included a count of mortality cases of watery diarrhea in CU5, count of mortality cases of bloody diarrhea CU5, and total mortality cases of acute malnutrition CU5. Among camps included in the WASH-Nutrition dataset, there were twenty-four (24) camps in Ethiopia, seven (7) in Kenya, twelve (12) in South Sudan, and fifteen (15) in Uganda.

Results

Characteristics of East African refugee camps

Number of Camps Studied for Diarrhea Morbidity, Population Mortality, and WASH-Nutrition Datasets

The distribution of camp level data from East African refugee camps by country from 2006-2016, including Ethiopia, Kenya, South Sudan, and Uganda is shown in Table 3-2. The total camps include fifty-nine (59) camps for Mortality data, fifty-eight (58) for WASH-Nutrition, and thirty-nine (39) for Diarrheal morbidity dataset. The total camps studied in all three (3) datasets represent sixty-seven (67) for Ethiopia, thirty-eight (38) for Uganda, thirty (30) for South Sudan, and twenty-one (21) for Kenya. Over the 11 years (2006-2016), the total camps studied for these three (3) databases numbered one hundred-fifty six (156) for Ethiopia, Kenya, South Sudan, and Uganda combined (Table 3-2).

Summary data for diarrheal morbidity data

Table 3-3 shows summary data for diarrheal morbidity in UNHCR East African refugee camps by country from 2006-2016. Country level grand mean was collapsed for HFU rate, the incidence of watery, and incidence bloody diarrhea in CU5 by year and country. The mean incidence of watery diarrhea among CU5 was highest in Ethiopia (61 cases/1000 CU5/month), Kenya (56 cases/1000 CU5/month), South Sudan (51 cases/1000 CU5/month), and lowest in Uganda (35 cases/1000/ CU5/month) (Table 3-3).

In comparison to the incidence of watery diarrhea, the mean incidence of bloody diarrhea among CU5 years old was lower, but countries ranked differently: the highest rate was in South Sudan (7.3 cases/1000 CU5/month), followed by Ethiopia (6.0

cases/1000 CU5/month), Uganda (2.5 cases/1000 CU5/month), and Kenya (0.7 cases/1000 CU5/month). For HFU rate, CU5 in Uganda utilize health services more often on average (2.5 consultation/person/month) than South Sudan (2.3 consultation/person/month), Ethiopia (1.8 consultation/person/month), and Kenya (1.7 consultation/person/month) (Table 3-3).

Summary data for WASH-nutrition data

Summary data for camp-level WASH-Nutrition standards among UNHCR East African refugee camps by country from 2006-2016 is given in Table 3-4. As indicated, UNHCR standards were used to measure some WASH and Nutrition indicators. These indicators are thus presented as dichotomous variables, where camps have either met the UNHCR standard or not. For example, camps may have an average of 22 liters of potable water per person, which is above the threshold of 20 liters of water recommended by UNHCR standard. Thus it *meets* the standard. Data for each of these indicators are presented in Table 3-4.

The average mean number of total population of CU5 children across East African refugee camps ranges from 83,679.12 (highest) in Kenya, to 53,065 in South Sudan, 51,392 Ethiopia, and 41,385 in Uganda (lowest) (Table 3-4).

For WASH indicators, variables examined (UNHCR standards) include the number of liters of potable water per person per day (>20 L), proportion of families with access to latrine (100%), percentage of families receiving at least 250 g (90%) of soap, percentage of HH) collecting at least 15 liters of water per day (80%); and proportion of water quality tests at chlorinated water collection locations compliant with standards (100%).

Based on the 2006-2016 HIS data for East Africa, the proportion of camps meeting the standard of >20 liters of potable water per person per day in South Sudan is 20%, in Ethiopia is 37.5%, in Kenya is 62.5%, and in Uganda is 62.5%. The proportion of camps reporting 100% of families with access to latrines was 80% for South Sudan, 50% for Ethiopia, 50% for Kenya, and 50% for Uganda. The proportion of camps reporting more than 90% of families receiving >250g soap in Ethiopia was 87.5%, 87.5% in Kenya, 80% in South Sudan, and 37.50% in Uganda. The proportion of camps reporting at least 80% of HH collecting at least 15 liters of water per day was 100% in Kenya, 62.50% in Uganda, 60%, in South Sudan and 50% in Ethiopia. Finally, the proportion of camps meeting water quality standards (reporting 100% of water quality tests at chlorinated water collection locations compliant with standards) was 50% in Ethiopia, 50% in Kenya, 50% in Uganda, and 20% in South Sudan (Table 3-7).

The prevalence of GAM is set by UNHCR standard to be <10% in refugee camps. From 2006-2016, the proportion of camps where this standard was met was quite low, ranging from the highest in South Sudan at 40.48%, followed by Ethiopia at 29.57%, Kenya at 23.53% and lowest in Uganda at 17.0% (Table 3-7).

HFU Rate, and Incidences of Watery and Bloody Diarrhea in CU5 across East African refugee camps: 2006-2016

Characteristics of Ethiopian refugee camps indicated by HFU rate, the incidence of watery and incidence of blood diarrheal among CU5 is shown in Table 3-5. The year each camp opened ranged from 1986-2014. The total number of observations by camp, which are monthly reports from 2006 to 2016, ranges from 51 in Shimelba to 1 in Leitchuro. The mean of HFU rate (consultation per person per months) ranges from 2.5 in Bonga to 0.1 in Tierkid in 2006-2016. The mean incidence of watery diarrheal among

CU5 (cases per 1000 population per month) ranges from 127 in Adi-Harush to 0.1 in Sheder. The mean incidence of bloody diarrhea in CU5 across Ethiopia refugee camps ranges from 17.3 in Shimelba to 0.1 in Sheder from 2006-2016(Table 3-5).Figure 3-1 shows the mean incidence of watery and bloody diarrhea among CU5 across Ethiopian refugee camps. When comparing the mean incidence of watery and bloody diarrhea among CU5 in Ethiopia camps, the 3 camps that show a major difference in each camp were: Adi-Harush, Bambasi and Sheder (Figure 3-1).

Table 3-6 shows characteristics of Kenyan refugee camps indicated by the mean of HFU rate, the mean incidences of watery diarrhea, and mean bloody diarrhea among CU5. By camp, the total number of observations from 2006-2016, ranges from a high 101 months of reported data in Kakuma to only 4 months of reported data in Kalobeyei. Compared to Ethiopian refugee camps, generally speaking, camps in Kenya a little later, ranging from 1991 (Kakuma) to 2015 (Kalobeyei). The mean HFU rate among reporting camps ranges from a high of 4.0 visits per person per month in Kalobeyei to only 1.2 visits per person per month in Hagadera. The mean incidence of watery diarrhea among CU5 per 1000 population per month in Kenya refugee camps ranges from 142.6 in Kalobeyei to 43.1 in Kakuma. The mean incidence bloody diarrhea among CU5 children per 1000 population per month in Kenya refugee camps ranges from 40 in Kalobeyei to 0.3 in Ifo and Hagadera respectively (Table 3-6). Figure 3-2 shows the mean incidence of watery and bloody diarrhea among CU5 across Kenyan refugee camps. When comparing the mean incidence of watery and bloody diarrhea in CU5 in Kenyan camps, the top three camps that had a highest incidence rate were: Kalobeyei, Kambioos, and Ifo2 (Figure 3-2).

Table 3-7 shows characteristics of South Sudan refugee camps indicated by mean of HFU rate, the mean incidence of watery diarrhea, and mean incidence of bloody diarrhea among CU5. By camp, the total number of observations from 2006-2016, ranges from a high 17 months of reported data in Lasu to only 1 month of reported data in Gorom. Compared to Ethiopian and Kenyan refugee camps, camps in South Sudan opened later, ranging from 2008 (Makpandu) to 2012 (Gendrassa, Ezo, and Kaya) (Table 3-7).

The mean HFU rate among reporting camps ranges from a high of 3.5 visits per person per month in Gendrassa to 1.3 visits per person per month in Lasu and Ezo. The mean incidence of watery diarrhea among CU5 per 1000 population per month in South Sudanese refugee camps ranges from 107.1 in Gendrassa to 2.7 in Ezo. The mean incidence bloody diarrhea among CU5 per 1000 population per month in South Sudanese refugee camps ranges from 15.1 in Gorom to 1.0 in Lasu (Table 3-7). Figure 3-3 shows the mean incidence of watery and bloody diarrhea among CU5 across South Sudanese refugee camps. When comparing the mean incidence of watery and bloody diarrhea in South Sudanese Camps, the top three (3) camps that has the highest rate of watery and bloody diarrhea were Gendrassa, Gorom, and Kaya (Figure 3-3).

Table 3-8 shows characteristics of UNHCR in Uganda refugee camps indicated by the mean HFU rate, mean incidences of watery and bloody among CU5, 2006-2016. Compared to Ethiopian, Kenyan, and South Sudanese refugee camps, camps in Uganda are much older established from 1959 (Oruchinga and Nakivale) to 2016 (Ikafe). The total number of observations by camp, which are monthly reports from 2006 to 2016; ranges from 70 in Kiryandongo to 13 in Ikafe. The mean HFU rate among

reporting camps ranges from a high of (6.0) visits per month in Nyakabanda to 0.9 visit per persons per month in Adjumani. The mean incidence of watery diarrhea among CU5 per 1000 population per month in Uganda refugee camps ranges from 142.4 in Nyakabanda to 6.8 in Imvepi. The mean incidence of bloody diarrhea in CU5 across Uganda refugee camps ranges from 7.1 in Nyakabanda to 0.2 in Imvepi from 2006-2016 (Table 3-8). Figure 3-4 shows the mean incidence of watery and bloody diarrhea among CU5 across Ugandans refugee camps, 2006-2016. When comparing the mean incidence of watery and bloody diarrhea in Ugandans Camps, the top three with highest rate were Nyakabanda, Kyaka II, and Imvepi (Figure 3-4).

Results of Diarrheal Mortality among CU5 across East African refugee camps: 2006 to 2016

Having provided an overview of the data sets by characterizing three main morbidity indicators by country; the mean HFU rate, the average mean incidence of watery diarrheal, among CU5, and the mean incidence of bloody diarrhea among CU5- the remainder of this chapter will focus on diarrheal mortality data. These data, presented for all UNHCR reporting East African refugee camps combined, include total counts of cause-specific mortality among CU5, by Sex and mean mortality cases of watery, bloody, and acute malnutrition among CU5.

Total counts of cause-specific mortality among CU5 by sex across all UNHCR reporting East African refugee camps

Table 3-9 shows the total counts of cause-specific, sex-disaggregated mortality among CU5 in East African UNHCR reporting refugee's camp between 2006 and 2016. Consistent with findings, a greater number of male children reportedly died from watery diarrhea (507) compared to female (440) (Table 3-9). There were also more mortality cases from bloody diarrhea among males (40) than females (32) (Table 3-9). In

contrast, the number of female children who reportedly died from acute malnutrition (807) was higher than males (796) (Table 3-9). Though the difference in these numbers is small, it is not anticipated, given that boys suffered from higher rates of malnutrition than girls do. Over the course of 11 years (2006-2016), the total number of reported deaths due to watery or bloody diarrhea and acute malnutrition was 2,622 across refugee camps in four East African countries (Table 3-9).

Average mean mortality cases of watery, bloody and acute malnutrition among CU5 in East African refugee camps.

Table 3-10 shows the characteristics of mean mortality cases of watery, bloody diarrhea, and acute malnutrition in CU5 East African refugee camps by country from 2006-2016. The number of possible observations for the country of Ethiopia was 1,396 camps (including the multiple camps counted in the course of 11 year). For Ethiopia refugee camps, the mean of mortality total cases of watery, bloody and all diarrhea (watery plus bloody) among CU5 was 0.12 /1000 (0.012%), 0.009/1000 (0.009%), and 0.13/1000 (0.013%) respectively. The mean mortality cases of acute malnutrition in Ethiopia refugee camps in CU5 children is 0.14/1000 (0.014%) (Table 3-10).

For Kenyan refugee camps, there were 265 total number of observations (multiple camps counts from 2006 to 2016). For Kenya refugee camps, the mean of mortality total cases of watery, bloody and all diarrhea (Watery Plus Bloody) among CU5 was 0.38 /1000(0.038%), 0.011/1000 (0.0011%) and 0.39/1000(0.039%) respectively. The mean of mortality total cases of acute malnutrition in Kenyan refugee camps among CU5 is 1.2/1000 (0.12%).

For the country of South Sudan, the number of observations was 383 (number of camps data collected including a camp being counted multiple times throughout the

years). For the hosting refugee country, South Sudan, the mean of mortality cases of watery, bloody and all diarrhea (watery plus bloody) among CU5 was 0.44 /1000 (0.044%), 0.039/1000 (0.0039%) and 0.48/1000 (0.048%) respectively. The mean mortality cases of acute malnutrition in South Sudanese refugee camps among CU5 is 0.14/1000 (0.014%) (Table 3-10).

Lastly, for Uganda, there was observations for nearly 11 years (2006-2016). For the Ugandan refugee camps, the mean of mortality cases of watery, bloody and all diarrhea (watery plus bloody) among CU5 was 0.07/1000 (0.007%), 0.013/1000 (0.0013%) and 0.09/1000 (0.009%) respectively. The mean mortality total cases of acute malnutrition in Ugandan refugee camps among CU5 is 0.08/1000 (0.008%) (Table 3-10).

Conclusion Remarks

This chapter has characterized morbidity and mortality associated with diarrheal disease among CU5 across East Africans refugee camps from 2006 to 2016. The researcher examined the total camps studied which ranges from 39 for Morbidity Diarrhea data, 58 for WASH-Nutrition Data and 59 for Mortality Diarrheal data from 2006-2016 (Table 3-2). The mean incidence of watery diarrhea among CU5 across East African refugee camps from 2006-2016 was highest (61/1000/month) in Ethiopia. In 2011, UNHCR documented that Acute Watery Diarrhoea (AWD) or cholera was endemic in five countries, Somalia, Djibouti, Uganda, and Ethiopia [49]. In Ethiopia, there was a documentation of a “newly reported outbreak of acute diarrhea” and “extensive flooding [which] displaced about 9,000 people hence at risk of communicable diseases including AWD” [49]. Some of the factors that may explain the higher incidence of watery in CU5 in Ethiopia include more refugee camps, (38.5%) compared

to (28.2%) in Uganda, (18%) in Kenya and (15.4%) in South Sudan (See Table 3-2). Also due to unforeseen civil war conflicts in neighboring countries such as South Sudan, Somalia, and Sudan, there has been a huge influx of refugees into Ethiopia. Recently, it was reported, “Ethiopia has overtaken Kenya to become Africa’s largest refugee-hosting country after hundreds of South Sudanese arrived in [Ethiopia]”[50].

South Sudan camps have the highest mean incidence of bloody diarrhea, 7.3/1000/month from 2006-2016. In 2012, UNHCR documented that there was a "sharp increase of bloody diarrhea cases "in Yida refugee camp in South Sudan, which experienced "newly arrivals [that has] doubled the refugee population" [51]. Furthermore, the average mean incidence of bloody diarrhea was lowest in Kenyan Refugee Camps (0.7/1000/months) from 2006-2016. The relatively low bloody diarrhea in Kenyan refugee camps may reflect “improved access to water and sanitation” [11] from 2006 to 2016.

Only 20% of South Sudanese refugee camps met the UNHCR Standard of camps reporting an appropriate number of liters of potable water available per person per day (>20L). UNHCR has documented that to address clean and sufficient drinking water, they are drilling more wells, additional amounts of chlorine are being used at water points, and they are working to increase awareness of WASH and nutrition strategies, specifically targeting the youth within the population of refugees [51]. Moreover, UNHCR distributed “thousands of jerry cans and buckets to all families with CU5” [51] to address this problem.

About 100% of Kenyan refugee camps met the UNHCR Standard of camps reporting more than 80% of HH collecting at least 15 liters of water per day. This finding may reflect improve access to water in the Kenyan refugee camps from 2006-2016.

When looking at the camp characteristics of reporting refugee camps across East African refugee camps, the higher mean incidence of watery diarrhea in CU5 are predominantly from newly established camps, ranges: 107/1,000/month in Gendrassa (2012) in South Sudan, 127/1,000/month in Adi Harush (2010) in Ethiopia, 142.4/1,000/month in Nyakabanda (2012) in Uganda and 142.6/1000/month in Kalobeyei (2016) in Kenya. In the HIS Data, it was clear that incidence of watery diarrhea among CU5 was more prevalent than the incidence of bloody diarrhea throughout the East African refugee camps from 2006-2016. In fact, the implementing agencies working along UNHCR should be aware of the high incidence of watery diarrhea when they are working in these camp settings.

From 2006 to 2016, the total count of cause-specific death among CU5 across East African refugee camps was 2622 (Table 3-9). Hershey et al. 2011 supported these findings by stating that “the relatively low proportion of deaths due to diarrhea may reflect improved access to water and sanitation”(p.24) [11] in [East African refugee camps] from 2006-2016.

Finally, camps in South Sudan have the highest child mortality due to watery diarrhea (44%) and bloody diarrhea (3.9%), as compared to camps in Ethiopia, Kenya, and Uganda (Table 3.10). UNHCR has documented the worsening scenario in refugee camps in the South Sudan, as they continue to receive large inflows of new refugees with heightened concern about implications for disease [51].

Table 3-1. Total registered refugees and asylum-seekers across East African refugee camps in 2017[39-42]

Country, Year	Total population of refugees/ asylum seekers	Nationality of refugees/ asylum seekers (number or proportion)	Proportion of CU5 among refugees/ asylum seekers	Sex composition of children under five among refugees/ asylum seekers
Ethiopia	829,925	South Sudanese:366,198 Somalis: 246,742 Eritreans: 168,447 Sudanese: 41,031 Yemenis: 1,643 Other Nationalities: 5,864	14.1%	Female:7.0% Male: 7.1%
Kenya	488,045	Somalia: 288,296 South Sudan: 107,806 DR. Congo: 13,450 Ethiopia: 17,891 Sudan: 2,952 Other: 3,915	15.3%	Female:7.5% Male: 7.8%
South Sudan	268,286	Sudan: 247,111 DRC: 14,548 Ethiopia: 4,738 CAR: 1,853	20%	Female: 9% Male:11%
Uganda	1,252,470	South Sudan: 898,864 DRC: 227,413 Burundi:45,993 Somalia:42,826 Rwanda:17,147 Others:20,227	Not provided	Not provided

Table 3-2. Geographic breakdown of camp level data included in UNHCR Diarrhea, Mortality, and WASH-Nutrition datasets from 2006-2016

Variable	Ethiopia	Kenya	South Sudan	Uganda	Total Camps Studied
# Camps Studied for Diarrhea Data	15	7	6	11	39
# Camps Studied for Mortality Data	28	7	12	12	59
# Camps Studied for WASH-Nutrition Data Data	24	7	12	15	58
Total # Camps Studied for all of the 3 datasets	67	21	30	38	156

Table 3-3. Summary data for diarrheal morbidity in UNHCR East African refugee camps by country level grand mean from 2006-2016

Variable	Ethiopia	Kenya	South Sudan	Uganda
Mean incidence of watery diarrheal in CU5	61	56	51.0	35
Mean incidence of bloody diarrhea in CU5	6.0	0.7	7.3	2.5
Mean of HFU rate	1.8	1.7	2.3	2.5

Table 3-4. Summary data of camp-level WASH-Nutrition standards met among UNHCR East African refugee camps by country from 2006-2016

Variable	Ethiopia	Kenya	South Sudan	Uganda
Country level grand mean Total Population of CU5	51,392	83,679	53,065	41,385
Percent of camps reporting appropriate number of liters of potable water available per person per day (>20L)	37.50%	62.50%	20.00%	62.50%
Proportion of camps reporting 100% of families with access to latrine	50.0%	50.0%	80.0%	50.0 %
Proportion of camps reporting >90% families receiving >250g soap	87.50%	87.50%	80.0%	37.50%
Proportion of camps reporting more than 80% of Household collecting at least 15 liters of water per day	50.0%	100%	60.0%	62.50%
Proportion of camps reporting 100% of water quality tests at chlorinated water collection locations compliant with standards	50.0%	50.0%	20.00%	50%
Proportion of camp/months reporting GAM Prevalence of less than 10%	29.57%	23.53%	40.48%	17.02%

Table 3-5. Camps characteristics of UNHCR reporting refugee camps in Ethiopia: 2006-2016

Country	Year Camp opened	Camp	#month Observed	Pooled mean of HFU rate consultation/person/ month	Pooled mean incidence watery diarrhea in U5 cases/1000 population/month	Pooled mean incidence bloody diarrhea in U5 cases/1000 population/month
Ethiopia						
	1986	Dimma	18	1.8	41	2.8
	1990	Bonga	19	2.5	48	5.4
	1991	Kebribeyah	22	1.2	20.3	0.3
	1993	Fugnido	22	0.9	18	3.2
	1997	Sherkole	29	1.4	25.1	4.4
	2004	Shimelba	51	2.1	75	17.3
	2007	Awbarre	12	0.9	34.5	6.6
	2010	Sheder	18	1.8	80	0.1
	2010	Bokolmanyo	2	0.74	11.2	1.5
	2011	Tongo	6	1.6	70	2.4
	2010	Adi Harush	2	0.5	127	30
	2008	Aysaita	2	1.2	45.5	0.5
	2012	Bambasi	1	1.8	89.1	10.4
	2014	Tierkidi	2	0.1	21	6
	2014	Leitchuor	1	1.7	39	11
Total number of months observed from 2006-2016	N/A	N/A	207	N/A	N/A	N/A

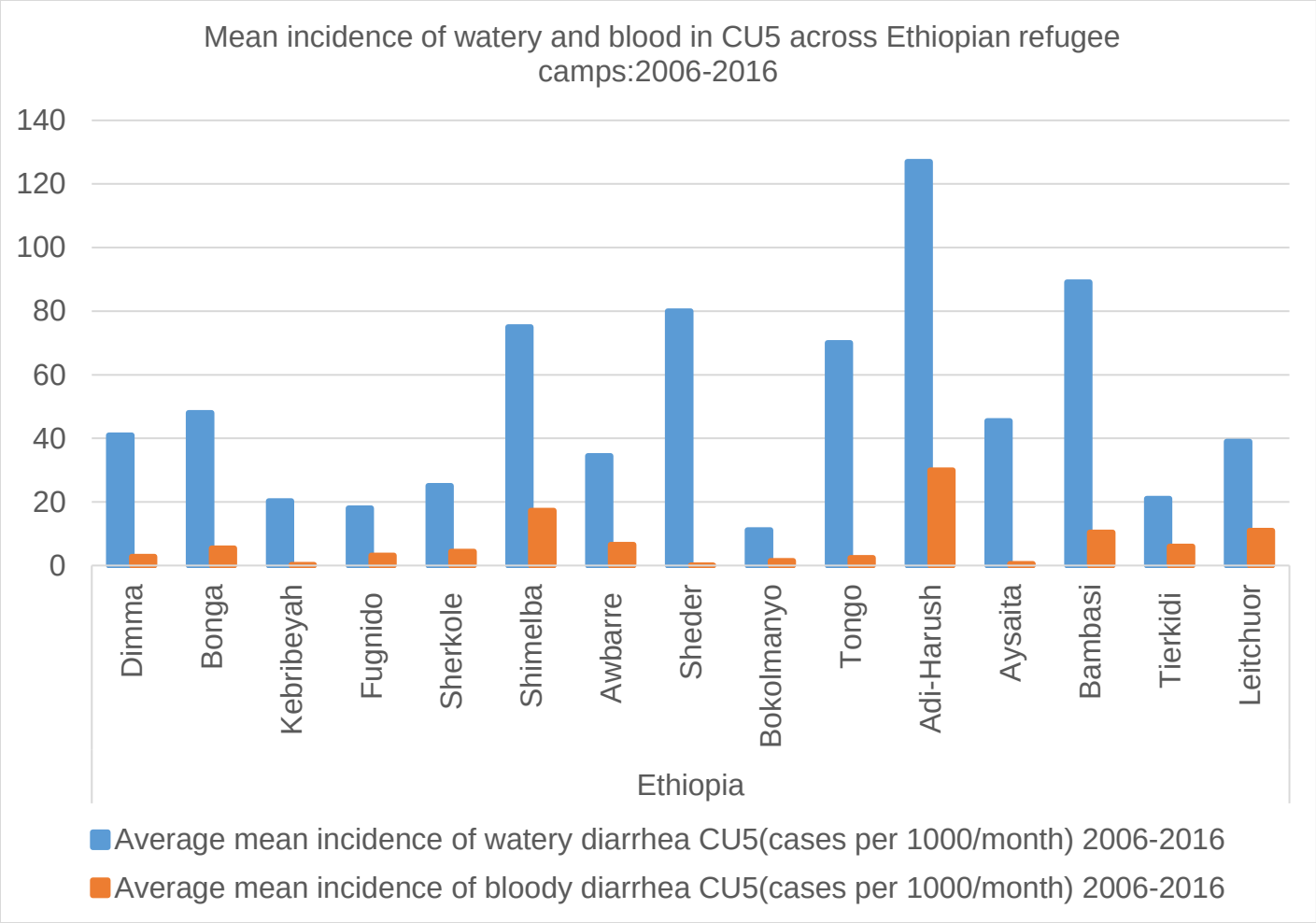

Figure 3-1. Mean incidence of watery and bloody in CU5 across Ethiopian refugee camps: 2006-2016

Table 3-6. Camp characteristics of UNHCR reporting refugee camps in Kenya: 2006-2016

Country	Year Camp opened	Camp	#month Observed	Pooled mean (HFU) rate consultation/person/ month	Pooled mean incidence watery diarrhea in CU5 cases/1000 population/month	Pooled mean incidence bloody diarrhea in CU5 cases/1000 population/month
Kenya						
	1992	Kakuma	101	1.8	43.1	0.5
	1992	Ifo	101	1.7	61.3	0.3
	1992	Dagahaley	101	1.6	59.1	0.7
	1992	Hagadera	101	1.2	43.3	0.3
	2011	Kambioos	62	2.0	64.0	0.8
	2011	Ifo 2	55	2.0	62.1	0.4
	2016	Kalobeyei	4	4.0	142.6	4.0
Total number of months observed from 2006-2016	N/A[D]	N/A	525 months observed	N/A	N/A	N/A

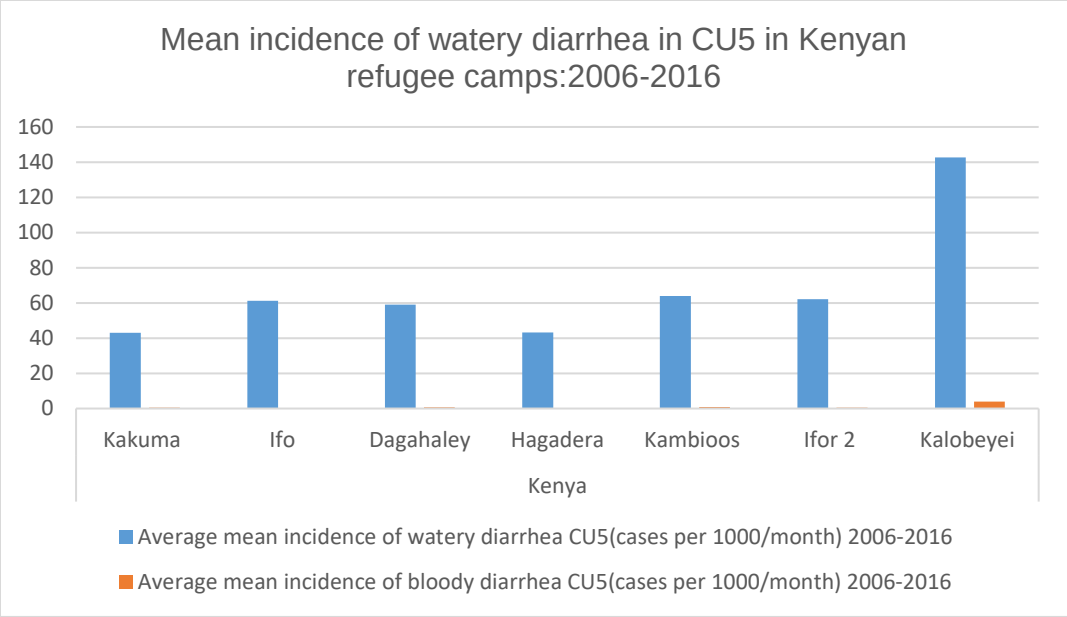

Figure 3-2. Mean incidence of watery and bloody diarrhea in CU5 in Kenyan refugee camps: 2006-2016

Table 3-7. Camp Characteristics of UNHCR reporting refugee camps in South Sudan: 2006-2016

Country	Year Camp opened	Camp	#month Observed	Pooled mean HFU rate [A]consultation/ person/month	Pooled mean incidence of watery diarrhea in CU5 cases/1000 population/month	Pooled mean incidence of bloody diarrhea in CU5 cases/1000 population/month
South Sudan						
	2008	Makpandu	12	2.1	54.2	7.6
	2009	Lasu	17	1.3	13.1	1.0
	2012	Gendrassa	14	3.5	107.1	7.3
	2012	Ezo	4	1.3	2.7	6.0
	2012	Kaya	11	3.3	80.0[C]	8.8
	2010	Gorom	1	2.4	93.0	15.1
Total month observed	N/A[D]	N/A	59 months observed	N/A	N/A	N/A

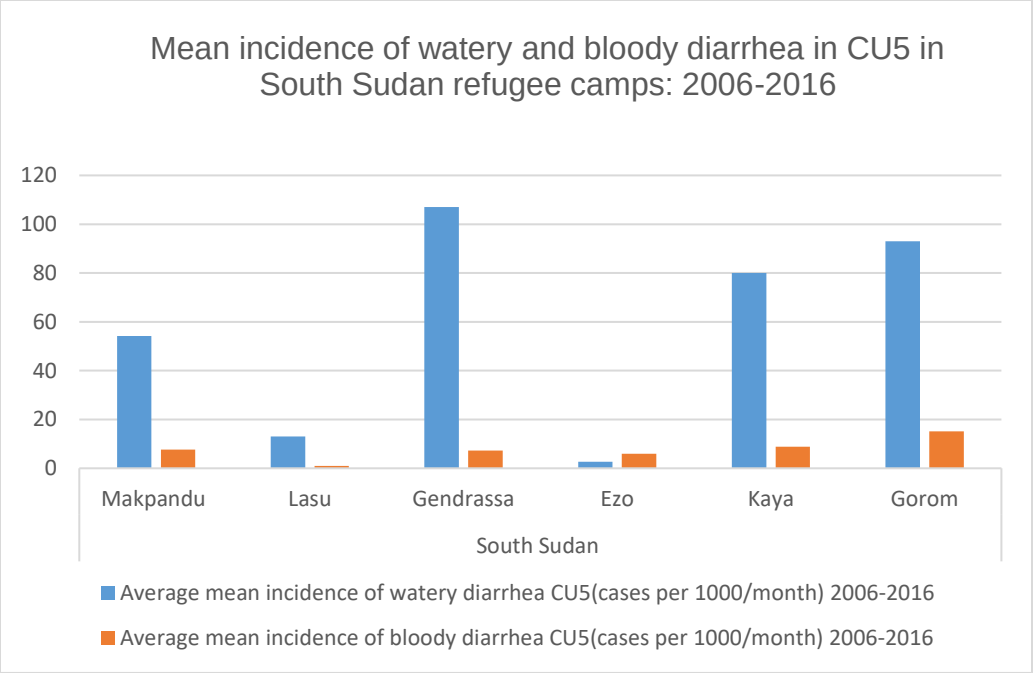

Figure 3-3. Mean incidence of watery and bloody diarrhea in CU5 in South Sudan refugee camps: 2006-2016

Table 3-8. Camp Characteristics of UNHCR reporting refugee camps in Uganda: 2006-2016

Country	Year Camp opened	Camp	#month Observed	Pooled mean of (HFU) rate	Pooled mean of Incidence rate of watery diarrhea in CU5 cases/1000	Pooled mean of Incidence rate of bloody diarrhea in CU5 cases/1000
Uganda						
	1995	Kiryandongo	70	2.0	13.0	0.61
	1968	Kyangwali	64	1.5	21.0	3.4
	1989	Adjumani	54	0.9	15.2	2.5
	1995	Rhino Camp	48	1.8	20.0	6.9
	1959	Oruchinga	46	3.4	22.0	1.5
	1959	Nakivale	39	1.7	17.0	2.0
	Reopened in 2016	Palorinya	36	1.3	15.2	4.0
	1983	Kyaka II	32	1.3	24.0	2.5
	2012	Nyakabanda	28	6.0	142.4	7.1
	2016	Imvepi	23	1.5	6.8	0.2
	N/A	Ikafe	13	1.2	23.9	4.5
Total months observed	N/A	N/A	453 months observed	N/A	N/A	N/A

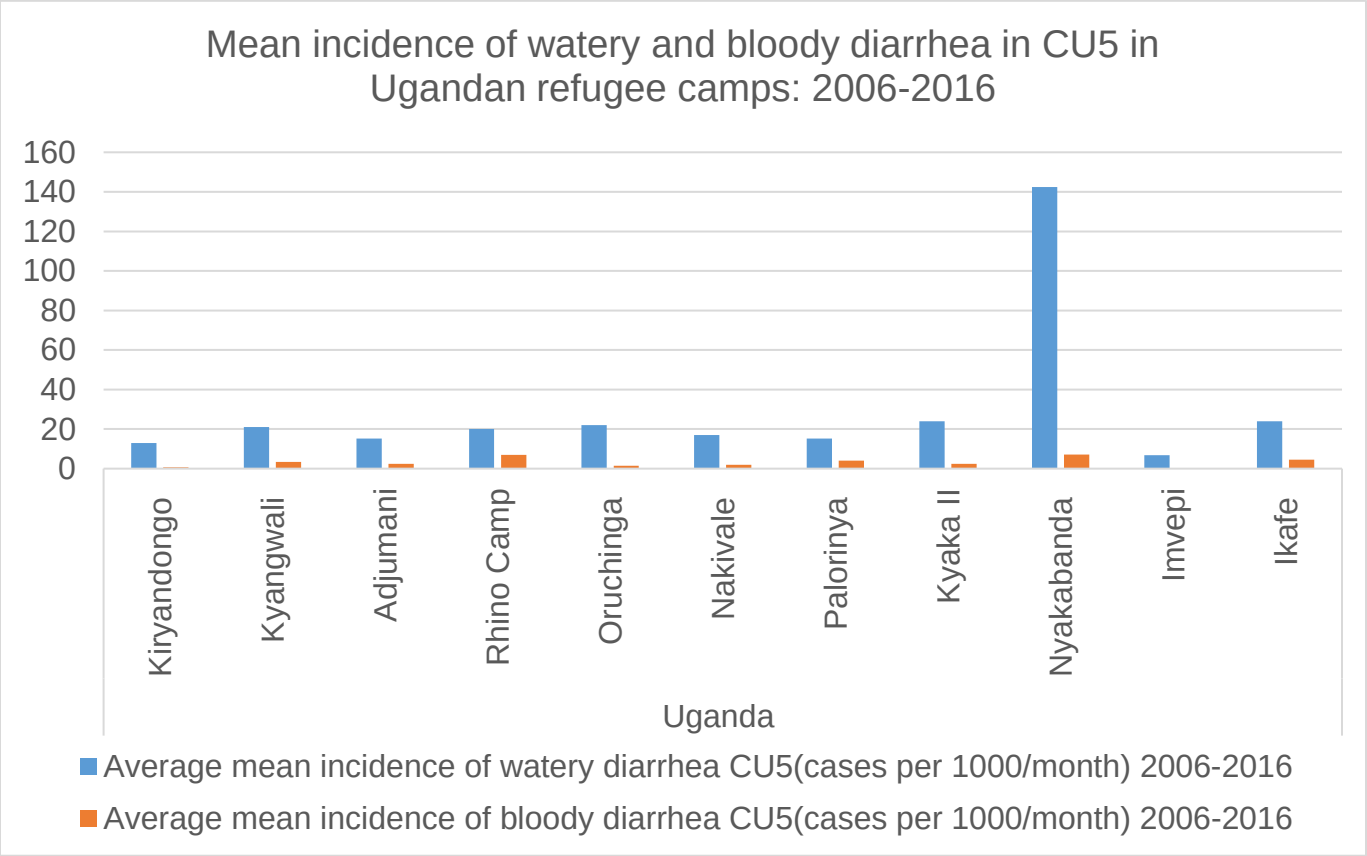

Figure 3-4. Mean incidence of watery and bloody diarrhea in CU5 in Ugandans refugee camps: 2006-2016

Table 3-9. Total counts of Cause-specific Mortality among CU5 by sex across all UNHCR reporting East African refugee camps 2006-2016.

Variable	*Total Counts/Sum*
Mortality cases from watery diarrhea (male)	507
Mortality cases from watery diarrhea(female)	440
Mortality cases from bloody(male)	40
Mortality cases from bloody (female)	32
Mortality cases from acute malnutrition(male)	796
Mortality cases from acute malnutrition (female)	807
Total Counts/sum	2622

Table 3-10. Child mortality due to watery, bloody diarrhea and acute malnutrition across East African refugee camps by Country level grand mean: 2006-2016

Country	Number of Observations (n)	Mean mortality cases of watery diarrhea <5 per 1000	Mean mortality cases of bloody diarrhea <5 per 1000	All mean mortality diarrhea (watery+bloody) <5 per 1000	Mean mortality cases of Acute malnutrition <5 per 1000
Ethiopia	1396	0.12	0.009	0.13	0.14
Kenya	265	0.38	0.011	0.39	1.2
South Sudan	383	0.44	0.039	0.48	0.14
Uganda	993	0.07	0.013	0.09	0.08

CHAPTER 4
A CROSS-SECTIONAL ANALYSIS OF RISK FACTORS FOR INCIDENCE OF WATERY DIARRHEA AMONG CHILDREN UNDER FIVE (CU5) IN EAST AFRICAN REFUGEE CAMPS IN 2016

Introduction

Global Burden of Diarrhea Disease in CU5

Diarrheal diseases are the leading causes of morbidity and mortality in CU5 in developing countries [34]. Another study conducted by Black and colleagues(2003) underscores that the three quarters of death of CU5 globally occur in sub-Saharan Africa and in South Asia (34% and 41%, respectively) [35]. Moreover, this study highlights that half of all mortality among CU5 occurs in only six countries: India, Nigeria, China, Pakistan, DRC, and Ethiopia [35]. A study in 90 UNHCR refugee camps found diarrheal disease as one of the major causes of morbidity (7%), and mortality (7%) among CU5 [11]. This research focus on the diarrheal disease among CU5 in East African refugee camps in Ethiopia, Kenya, South Sudan, and Uganda, in 2016.

Current Understanding and Knowledge of 'Risk Factors' Related to Diarrheal in Africans refugee camps.

To reduce morbidity and mortality in refugee camps, there has to be a good healthcare system, clean water, and sufficient food rations [52-54]. Hershey et al., (2011), emphasized that a lack of sanitation and contamination of drinking water contribute to increased risk of diarrhea in 90 UNHCR refugee camps [11].

UNHCR is mandated by the UN to provide clean water to refugees as a basic human right [55], but there is still a lack of adequate access to water and sanitation in many refugee hosting-countries, including; Uganda, Chad, Kenya, and DRC [55].

An illustration of the impact of a lack of clean water was seen in 1994, when Rwandans fled genocide as refugees to DRC, and around 60,000 people died due to

"water shortage and consequent cholera" (p.12-14) [55].These findings are reinforced by additional empirical evidence showing that unsafe water sources are associated with diarrheal disease among refugees [56].

In the refugee camp settings, women perform a majority of domestic labor including water and fuel collection outside of the refugee camps. In Uganda, it has been reported that when women collect water outside of the camps, they often became victims of violence and rape, begin attacked by the rebel group, the Lord's Resistance Army (LRA) [55]. It is thus understable, in such circumstances where women fear for their lives, that they may resort to collecting water that is known to be "contaminated, or coming from unhygienic sources" (p.12-14) [55]. These cost-benefit analyses are a daily part of many women's lives.

Finally, the other important risk factors for diarrheal disease in the refugee camps that have been documented are overcrowding, inadequate shelter, poor access to water and sanitation and sharing a latrine [11, 16].

Rationale for Conducting a Study on Risk Factors for Incidence of Watery Diarrheal among CU5 in East Africans refugee camps in 2016.

In 2015, the United Nations (UN) launched the Sustainable Development Goals (SDG) in an effort to garner global support and coordinate efforts among the agencies that provide health services, clean water and sanitation. SDG 3 is to reduce child mortality [57], and SDG 6 is to secure water and sanitation by 2050 [58]. Meeting SDG 3-Good Health, and SDG 6-Clean Water and Sanitation will require a better understanding and interventions to improve the status of refugee camps across the world [59].

One of the SDG Goal 3 targets is "to end preventable deaths of newborns and [CU5] with all countries aiming to reduce neonatal mortality to at least 12 per 1,000 live births and [CU5] mortality to at least 25 per 1,000 live births" by 2030 [60]. For SDG 6, the target according to the United Nations Development Programme (UNDP) to achieve universal and equitable access to safe and affordable drinking water, achieve access to adequate and equitable sanitation and hygiene, and end open defecation by 2030 [61].

To fulfill and implement SDGs 3 and 6, there is a need to conduct a systematic review of the existing risk factors, morbidity, and mortality associated with diarrheal disease among CU5. There is also a need to understand how the risk factors of refugees may differ from those of other populations, and there is a need to quantify risk factors that are statistically associated with diarrheal disease in CU5 such that agencies working in these refugee camps can develop data-driven strategic plans to improve children lives and meet the SDGs.

These gaps were highlighted in a 2008 study in which the authors pointed out that “research on water, sanitation, and hygiene promotion issues among refugee populations has remained a challenge" (p.1-13) [37]. Authors explained that the death of data available on refugees is at least in part due to the difficulty of collecting data in the refugee camps because of "security restrictions, complex operational conditions, scarce resources, understaffing or high staff turnover, and the fact that refugee camps are forcibly located on marginal lands" (p.1-13) [37]. All these factors combine to limit our knowledge and understanding-thus ability to intervene-of the impact of diarrheal disease on refugee children.

East Africans Refugee Hosting Countries in 2016

UNHCR routinely monitors selected demographic, public health, and WASH indicators across East African refugee camps. UNHCR produced a 2016 report on the East African refugee hosting countries that is available on the UNHCR website titled "*UNHCR Public Health 2016 Annual Global Overview*" [62]. UNHCR produces yearly site reports for each camp, providing information on key health indicators and services that fall below or meet the UNHCR standards[11]. For example, UNHCR has standard indicators such as Health Utilization (HU) rate (1.4-new visits/person/year), the average liters per person per day (>20), and the average person's/ communal toilets (<20).

Table 4-1 shows East African refugee-hosting countries in 2016. The total number of registered refugees in Ethiopia was 742,725, 15% of whom are CU5. The origins of the refugees registered were: South Sudan, Somali, Eritrea, and various other countries [63]. Additionally, the HU rate ranged from 0.3-2.9 new visits/person/year, the average number of liters water/ person/ day was 13-26, and the number of person's/communal toilets was between 5-56 (Table 4-1).

In 2016, the total registered refugee population in Kenya was 523,498, the proportion of CU5 was 16%, and home countries of the refugee were Somalia, South Sudan, Ethiopia, and DRC [64]. In Kenyan refugee camps, the HU rate was 1.5-2.9, the average liters of water/ person/ day was 13-36, and the number of persons/ communal toilets was 3.4 to 10.8 in 2016 [64] (Table 4-1).

The total population of registered refugees for South Sudan in 2016 was 763,752, the proportion of CU5 was 22%, and the origin of refugees included Sudan, DRC, Central African Republic (CAR) and Ethiopia [65]. Among refugees in South

Sudan in 2016, the HU rate was 0.8-3.5, the average liters of water/person/day ranged from 15-21, and the number of persons/communal toilet in South Sudan refugee camps was 7.6-43.1 in 2016 (Table 4-1) [65].

In 2016, The total registered refugees in Uganda camps was 828,862, the proportion of CU5 was 20%, and most refugees in Uganda were from South Sudan, DRC, Somalia, and Burundi [66]. Among registered refugees in Uganda, the HU rate ranged from 0.4-5.6, the average liters of water/person/day was 13-32, and the person per communal toilets/latrines was 3.7-44.0 (Table 4-1) [66].

In 2016, camps in Uganda had the largest total population of refugees (828,862 individuals) compared to other East Africans countries and these refugees utilize health services more frequently compared to refugees in camps in Ethiopia, Kenya, and South Sudan (Table 4-1). In 2013, civil war broke out in the newest nation of South Sudan, and many South Sudanese fled the conflict into Uganda, where they remain today as refugees. Also, plenty of refugees are fleeing DRC due to the ongoing civil war there, again, arriving as refugees in Ugandan camps. The influx of refugees from Ugandan's neighboring countries into Uganda refugee camps has a tremendous impact on livelihood of the vulnerable populations who resided in these refugee camps. Moreover, the more refugee utilizes health services in Ugandans camps, the more they will increase the high risk of incidence of watery diarrheal in these refugee camps.

Research Question

The documented burden of diarrheal disease in the refugee camps, especially among the vulnerable population such as children, and commitment to contribute to the UN efforts to fulfill the SDGs contributed to the development of the following

research question, "What are the primary risk factors for watery diarrheal among CU5 in East African refugee camps in 2016?.

Methods

Study setting

Diarrheal disease is one of the major causes of morbidity and mortality among CU5 in the refugee camps. This study is a cross-sectional analysis of risk factors for watery diarrhea among CU5 in East Africans refugee camps in 2016 with a specific focus on Ethiopia, Kenya, South Sudan, and Uganda. Through the UNHCR Public Health 2016 Annual Global Review, the research is based on reports for 23 camps in Ethiopia, 7 refugee camps in Kenya, 8 refugee camps in South Sudan, and 9 refugee camps in Uganda [64].

Data

For this research, the dependent variable (DV) was the incidence of watery diarrhea in CU5 in East African refugee camps, and the independent variables (IV) were categorized into key health indicators including information on demographics, public health service usage, water availability, and sanitation and hygiene (WASH) (Table 4-2).

The researcher created an excel table and extracted the DV and IVs based on the 2016 camp level reports. The incidence of watery diarrhea among CU5 at each camp level was imported to the excel table. The demographic indicators extracted included the origins of refugees, the age of the camp, and proportion of CU5 across East African refugee camps. The public health variables imported into the excel chart were the HU rate and the proportion of host population consultations for 2016 (Table 4-2). The WASH Variables included were the number of concerned persons per water tap, proportion of households collecting drinking water from protected water sources only,

proportion of households with sufficient daily water storage capacity, refugees per latrine/toilet, proportion of households with drop-hole latrine, and proportion of households reporting defecating in a toilet (Table 4-2). These data were extracted saved as a new dataset that was then exported from excel as a CSV file, and imported into Stata 11.1 (StataCorp, College Station, Texas 77845 USA) for Data analysis.

For measurement of the DV, the incidence of watery diarrhea was defined as “passage of 3 or more watery or loose stools in 24 hours, with or without dehydration" (p.1-43) [48]. The UNHCR report contained the incidence of watery diarrheal among CU5 in East Africans Refugee camps for 2016, thus this data was extracted and added to the dataset.

The refugee’s country of origin was coded as a binary variable (0 =fixed, and 1=mixed) (Table 4-2), where fixed represents one single country of origin (i.e., South Sudanese), and mixed represents multiple countries of origin (i.e., South Sudan and Somalia or more). Another variable that was created was the age of the camp. To create this variable, the researcher subtracted the year camp opened from the year of the study (i.e., 2016 minus 2006 = 10 years the camp has been opened).

Also for this study, the researcher used the UNHCR definition of standards and indicators. A standard is defined as “a specific fixed point or range on the variable scale (indicator) that has to be reached or maintained to avoid the occurrence of unacceptable conditions for refugees and persons of concern or unacceptable levels of performance. The indicator is defined as "a variable scale on which it is possible to measure different points objectively, and that corresponds to or correlates closely with variations in the conditions of the refugee and persons of concern" [67] (Table 4.2).

The IVs were examined for their association with incidence of watery diarrhea in CU5 across East African refugee camps in 2016.

Data Analyses

Data analysis was conducted in R 3.4.2 software, and included summary measures incidence of watery diarrhea in East African refugee camps in 2016. The researcher conducted a univariate and multivariate Gamma Distribution regression analysis to identify risk factors associated with the incidence of watery diarrhea disease. The researcher used the Gamma Distribution because most of the variables were continuous with a skewed distribution, and the DV is "real-valued" in a range from zero to thousands (0-1000) [68]. For the univariate regression, the researcher was able to model the DV dependent (incidence of watery diarrhea) with Gamma Distribution by each IV shown in Table 4-4. This Table 4-4 also displays the coefficient and p-value as summary measures of the regression results.

The researcher first created the univariate models for each of the risk factors and IVs that, might affect the yearly incidence of watery diarrhea in each camp. If the researcher found that the risk factor (covariates or IVs) were even marginally significant (using $p<.2$), the researcher considered those variables for inclusion in the final multivariate model for predicting the incidence of watery diarrhea, considering these risk factors as potential predictors for the incidence of watery diarrhea.

After fitting the final multivariate model, the researcher excluded the variables gradually according to the highest p-value, retaining only those variables in the model significant at the .05 level or below (Table 4-5).

The researcher mapped the location of camps in ArcMap 10.5.1 and then mapped attributed data on the incidence of watery diarrheal among by the refugee

hosting-countries for 2016. The researcher then mapped the country-aggregated average mean and Standard Error (SE) of the mean for the significant variables by host-country (Table 4-5).

Results

Camp Characteristics of the IVs in East African Refugees Camps in 2016

Table 4-3 shows camp characteristics of the IVs in East African refugee camps in 2016. Over a third refugees came from mixed or multiple countries of origin (36%). The mean average camp age for East African refugee camps was 13 years in 2016. The proportion of CU5 across the East African refugee Camps in 2016 was 21%.

Across East African refugee camps in 2016, the average mean HU rate was 1.64 new visits/ refugee/year, which met UNHCR standard for HU rate of 1-4. The proportion of host population consultations (surroundings communities around the refugee camp) was (16%) in 2016. The average mean number of liters of potable water available per person per day was 20.4, which did not meet UNHCR Standard of >20 liters of potable water need for person per day. The average mean number of persons of concern per water tap in East African refugee camps in 2016 was 191.5, which did not meet UNHCR Standard of <80 number of person of concern per water tap. The proportion of households collecting drinking water from protected water sources only in East African refugees camps in 2016 was (99%) which did meet UNHCR Standard of >95% (See Table 4-2 and Table 4-3).

The proportion of households with sufficient daily water storage capacity in East African Refugee camps, 2016 was 62% which did not meet UNHCR standard of >80% (Table 4-3). The average mean number of refugees per toilet in East African refugee camps in 2016 was 17.0, which met the UNHCR standard of <20 (Table 4-2). The

proportion of households with drop-hole latrines was 54% across the regions.No UNHCR Standard was provided for this indicator).The proportion of households reporting defecating in a toilet was (92%), which exceeded the UNHCR Standard of >85% (Table 4-2).

Table 4-4 shows univariate analysis for selected demographics, access and utilization, water, sanitation and hygiene (WASH) indicators for the incidence of watery diarrhea among CU5 in 2016. For camps under consideration, the camps with the mixed country of origin had a lower risk of incidence of watery diarrhea (coefficient -0.61, p-value 0.65) compared to the single country of origin camps (coefficient -0.48, P-value 0.6). An increase in the age of the camp increase the incidence of watery diarrhea by 4 per thousand (coefficient 0.004, p-value, 0.1). One unit increase in the proportion of CU5 in the refugee camps significantly increase the incidence of watery diarrhea by 0.0735 units (coefficient 0.0735, p-value, 0.01). Each one-unit increase in the HU rate significantly reduces the risk of incidence of watery diarrhea by 49% (-0.0049, p-value 0.00) (Table 4-4).

A one-unit increase in the proportion of host population consultations increase the incidence of watery diarrhea by 0.0373 units (coefficient, 0.0373 p-value 0.1,) among CU5 across East Africa Refugee camps in 2016. A one-unit increase in the mean number of liters of potable water available per person per day reduces the incidence of watery diarrhea by 0.0007 times (coefficient 0.0007, p-value 0.1) (Table 4-4). A one-unit increase in the number of persons of concern per water tap significantly reduces the incidence of watery diarrhea by 0.004 units (Coefficient 0.0044, p-value 0.03).

A one-unit increase in the proportion of households with sufficient daily water storage capacity significantly reduces the incidence of watery diarrhea by -00.019 times (coefficient -00.019, p-value 0.03). A one-unit increase in refugees per latrine/toilet reduces the incidence of watery diarrhea by -0.0122 times (coefficient -0.0122, p-value 0.2). A one-unit increase in the proportion of households with drop-hole latrines reduces the incidence of watery diarrhea by -0.013 times (coefficient -0.013, p-value 0.1). A one unit increase in the proportion of households reporting defecating in a toilet reduces the incidence of watery diarrhea by -0.044 times/units (coefficient 2.0, p-value 0.1) among CU5 across East Africa Refugee camps in 2016 (Table 4-4).

Table 4-5 shows, Multivariate Analysis of Incidence of Watery Diarrheal among CU5 across East African Refugee camps in 2016 including demographics, access and utilization, water, sanitation and hygiene (WASH) indicators. The multivariate model showed the following: One year increase in the age of the camp, increase the incidence of watery diarrheal by 0.03 units (Coefficient 0.03, p-value, 0.2). A one-unit increase in the proportion of CU5 in the refugee camps significantly increase the incidence of watery diarrhea by 0.8 (coefficient 0.8, p-value, 0.002). A one-unit increase in HU rate significantly reduces the reporting of the incidence of watery diarrhea by -0.6 units (-0.6, p-value 0.03) (Table 4-5). A one-unit increase in proportion of host population consultations increase the incidence of watery diarrhea by 0.03 units (coefficient 0.005, p-value 0.9). A one unite increase in average number of litres of potable water available per person per day; increase the incidence of watery diarrhea by 0.005 units (coefficient 0.005, p-value 0.9).

A one unit increase in the number of persons of concern per water tap increase the incidence of watery diarrhea by 0.002 (0.002, p-value 0.2). A one-unit increase in proportion of households with sufficient daily water storage capacity increase incidence of watery diarrhea by 0.04 units (coefficient 0.04, p-value, 0.9). A one-unit increase in proportion of households with drop-hole latrine increase incidence of watery of diarrhea by 0.05 units (coefficient 0.05, p-value 0.9). A one-unit increase in the proportion of households reporting defecating in a toilet reduces the incidence of watery diarrhea by -0.1 times (coefficient -0.1, p-value 0.6) among CU5 in East Africa refugee camps in 2016 (Table 4-5).

Sample Sizes of the Multivariate Significant Variables by Hosting refugee Countries in 2016

Table 4-6 shows sample size of the significant multivariate variables by hosting refugee countries in 2016. For the average mean incidence among CU5, the sample size range from 7 camps in Kenya, 8 camps in South Sudan, 9 camps in Uganda and 23 camps in Ethiopia. For the average mean proportion of CU5, and average mean HU rate, the sample size was similar to the incidence sample size mentioned above (Table 4-6).

For the average mean number of persons of concern per water tap, the sample size range from 5 camps in South Sudan, 7 camps in Kenya, 8 camps in Uganda, and 23 camps in Ethiopia. The average mean refugees per latrine sample size range from 7 camps in Kenya, 8 camps in South Sudan, 10 camps in Uganda and twenty-three camps in Ethiopia. Finally, the average mean proportion of households reporting defecating in a toilet sample size range from 5 camps in South Sudan, 7 camps in Kenya, 8 camps in Uganda and twenty-three camps in Ethiopia (Table 4-6).

Mapping the Incidence of Watery Diarrheal among CU5 in East African refugee camps by Country in 2016.

Figure 4-1 shows a map of the locations of camps with the incidence of watery diarrhea in CU5 in East African Refugee camps in 2016. The incidence of watery diarrhea diseases (cases per 1,000/CU5 /month) is shown over the camps of each hosting-countries in 2016. The map of the locations of camps were divided into 5 quintiles as indicated by the size and color of the circles and the incidence of watery diarrheal (Figure 4-1). Figure 4-1 highlights the heterogeneity at the refugee host-country level in watery diarrheal disease incidences across region

Five panels map of the average mean and the Standard Error (SE) of the mean for the significant multivariate variables.

Figure 4-2 shows the average mean and the Standard Error (SE) for the multivariate model of variables that were significantly associated with the incidence of watery diarrhea. Figure 4-2, shows the average mean and the SE of the mean for each variable by the hosting-refugee countries.

In East African Refugee camps in 2016, the average mean HU rates are 1.12 in Ethiopia, 2.03 in Kenya, 2.13 in Uganda, and 2.29 in South Sudan, and the SE of the mean range are 0.14 in Ethiopia, 0.29 in Kenya, 0.4 in South Sudan, and 0.49 in Uganda (Figure 4-2).

The average mean proportion of CU5 in the East African Refugee camps are 18% in Kenya, 21% in Uganda, and 22% for both Ethiopia and South Sudan. The SEs of the mean range from 1% for both Kenya and South Sudan camps, 2% in Uganda, and 4% for Ethiopia (Figure 4-2).

The average mean number of Persons of Concern per Water Tap (PCWT) vary throughout the region: 84.29 in Kenya, 99.04 in Ethiopia, 104.6 in South Sudan, and

605.25 in Uganda. The SE of the means range from 8.23 in Ethiopia to 170.09 in Uganda (Figure 4-2).

The average mean Refugees per Latrine (RPL) in East African refugee camps in 2016 are 5.71 in Kenya, 13.4 in Uganda, 15.25 in South Sudan, and 22.57 in Ethiopia. The SEs of the mean range from 0.97 in Kenya to 4.5 in Ethiopia (Figure 4-2).

The average mean of proportion of Households reporting Defecating in a Toilet (HDT) are all above 85% in Uganda to 100% in Kenya. The SE of the mean are 0% in Kenya, 1% in South Sudan, 2% in Ethiopia, and 3% in Uganda (Figure 4-2).

Discussion

Analysis of UNHCR Public Health 2016 Annual Global Overview data from 47 East African refugee camps in 4 Countries: Ethiopia, Kenya, South Sudan, and Uganda.

The study has selected key health indicators from UNHCR Public Health 2016 Annual Global Overview data from 47 East African Refugee camps in 4 countries: Ethiopia, Kenya, South Sudan and Uganda. Most of the refugees in East Africa come from multiple countries of origin (36%) (Table 4-3). In fact, the author included the mixed origin of refugees in the study as a potential risk factor because, in the refugee settings, most refugees do not have a choice on which camp they should live. As a result, the refugees are gathered together into whatever camp they are deemed to fit according to UNHCR regulations and accessibility or convenience of the refugees traveling into the camp. For example, Kakuma Refugee camp in Northern Kenya consists of refugees from South Sudan, Somalia, and Ethiopia. Imagine these refugees being congregated into this overcrowded camp, and the differences in cultural background and health beliefs that make them prone to diarrheal, particularly with CU5. Surprisingly, the mixed

origin of refugees was not significantly associated with the incidence of watery diarrhea in the univariate analyses (Table 4-4).

Neither the average number of liters of potable water available per person per day, nor households with drop-hole latrine were found to be statistically significantly associated with the incidence of watery diarrhea (Table 4-4). In addition, camp age, proportion of host population consultations, number of refugees per latrine, and proportion of households reporting defecating in a toilet were found to be not statistically significantly associated with the incidence of watery diarrhea (Table 4-4).Finally, in the univariate analysis, proportion of CU5, Health Utilization (HU) rate, average number of persons of concern per water tap, and proportion of households with sufficient daily water storage capacity were significantly associated with incidence of watery diarrhea (Table 4-4).

In the multivariate model, the proportion of CU5, and HU rate was significantly associated with the incidence of watery diarrhea among CU5 in East African refugee camps in 2016 (Table 4-5). In the multivariate model, it was found: camp age, proportion of CU5, proportion of host population consultations, average number of liters of potable water available per person per day, a number of persons of concern per water tap, proportion of households with sufficient daily water storage capacity, proportion of households with drop-hole latrine, and proportion of households reporting defecating in a toilet not significantly associated with incidence of watery diarrheal among CU5 in East African refugee camp.

In 2016, Ugandans refugee camps had the highest incidence of watery diarrhea (214 per 1,000 per month) among CU5. This is, indicated by the size and color of the

circles (Figure 4-2) compared to Ethiopians, Kenyans and South Sudanese refugee camps in 2016.

In 2016, refugees in South Sudanese camps utilized health services more (2.29) (Figure 4-2) compared to other refugee camps in East Africa. This finding might be because South Sudanese camps have the highest proportion of CU5 (22%) compared to the proportion of CU5 in Ethiopian, Kenyan, and Ugandans camps in 2016 (Table 4-1).

Also, in 2016, all of the East African refugee camps met the UNHCR standard for the of HU rate (1-4 new visits/refugee/year) (Figure 4-2). On the other hand, when it comes to the average mean number of persons of concern per water tap in 2016, none of East African Refugee camps met the UNHCR standard of <80 (Figure 4-4). The average mean for some persons of concern per water tap in Ugandans refugee camps was 8 times (605.25) higher compared to the UNHCR standard of <80; this should raise concerns for the implementing agencies working in these refugee camps. Also in 2016, there is documentation of an influx of refugees from South Sudan and the DRC into Uganda, which may have affected the services being given to the refugees across the camps.

Regarding the average mean refugees per latrine, the refugee camps in Kenya, Uganda, and South Sudan met the UNHCR standard of <20; but refugee camps in Ethiopia fell below this standard in 2016. In addition, all of the East Africans Refugee camps met the UNHCR standard of >85% average mean for the proportion of households reporting defecating in a toilet in 2016.

One of the limitations of conducting the cross-sectional study on risk factors for incidence of diarrheal disease among refugee CU5 is that there were not enough data points to have a robust statistical analysis. The study is based on only studied 47 East Africans Refugees camps for whom 2016 data were available. For future studies, data from 2011-2016 can be used to provide a more robust underpinning to the statistical findings here.

Table 4-1. East African Refugee camps hosting Countries reports for 2016

Country, Year	Total population of refugee	Proportion of children under five	Country Origin of refugees	Camps refugees resided	Health Utilization Rate-new/person/ year	Proportion of Primary Healthcare consultations for watery diarrhea	Average liters/person/ day	Persons per communal toilets/latrines
Ethiopia, 2016	742,725	15%	S. Sudanese, Somali, Eritrean Various	Tsore Kule Tongo Fugnido Kebriebeyah Sheder Bokolmanyo Barahle Bambasi Sherkole Okugo Leitchuor Melkadida Awbarre Shimelba Buramino Aysaita Fugnido 2 Hitstats Adi-Harush Hilaweyn Mai-Aini Tierkidi Kobe	0.3-2.9	8.6%	13-26	5-56

Table 4-1. Continued

Country, Year	Total population of refugee	Proportion of children under five	Country Origin of refugees	Camps refugees resided	Health Utilization Rate-new/person/ year	Proportion of Primary Healthcare consultations for watery diarrhea	Average liters/person/ day	Persons per communal toilets/latrines
Kenya, 2016	523,498	16%	Somalia S. Sudan, Ethiopia DRC	Kalobeyei Hagadera Nairobi Kakuma Dagahaley Kambioos IFo Ifo2	1.5-2.9	Not Available	13-36	3.4-10.8
S.Sudan, 2016	263,752	22%	Sudan DRC CAR Ethiopia	Parmir Ajuong Thok Kaya Gorom Panrieng Bunj Hospital Gendrassa Doro Makpandu Yida Yusuf Batil Lasu Ezo	0.8-3.5	8.4%	15-21	7.6-43.1

Table 4-1. Continued

Country, Year	Total population of refugee	Proportion of children under five	Country Origin of refugees	Camps refugees resided	Health Utilization Rate-new/person/ year	Proportion of Primary Healthcare consultations for watery diarrhea	Average liters/person/ day	Persons per communal toilets/latrines
Uganda, 2016	828,862	20%	S.Sudan DRC Somali Burundi	Bidibid Adjumani Rwamwanj a Kyangwali Kyaka II Nyakaband e Ikafe, Lobule Lawmwo Nakivale Oruchinga Kiryandong o Rhino Camp, Polorinya Kampala	0.4-5.6	5.3%	13-32	3.7-44.0

Table 4-2. Summary of the Exposure variables extracted from East African hosting Countries reports in 2016

Name of variable	Variable type (e.g. categorical or continuous and binary	Indicator at the Camp level, 2016	UNHCR Standard/definition at the camp level, 2016
Origin of Refugees	Binary	Created variable: 0=fixed country of origin (i.e, South Sudan), 1= mixed country of origin (i.e., South Sudanese and Somali).	Not available (N/A)
Camp Age	Continuous	created this variable by subtracting the month and year the camp is open by 2016(i.e., January 1958-2016 =	Not Available (N/A)
Health Utilization rate	Continuous	X Number given at the camp level	1-4 new visits/refugee/year
Proportion of Host Population Consultations	Continuous	X Proportion gave at the camp level	Not Available (N/A)
Average number of liters of potable water available per person per day	Continuous	X Number is given at the camp level	>20 Litres
Number of persons of concern per water tap	Continuous	X Number is given at the camp level	<80
Proportion of households collecting drinking water from protected water sources only	Continuous	X Proportion gave at the camp level	>95%
Proportion of households with sufficient daily water storage capacity	Continuous	X Proportion gave at the camp level	>80%
Refugees per latrine/toilet	Continuous	X Number given at the camp level	<20

Table 4-2. Continued.

Name of variable	Variable type (e.g. categorical or continuous and binary	Indicator at the Camp level, 2016	UNHCR Standard/definition at the camp level, 2016
Proportion of households with drop-hole latrine	Continuous	X Proportion gave at the camp level	No Standard provided
Proportion of households reporting defecating in a toilet	Continuous	X Proportion gave at the camp level	>85%

Table 4-3. Camp characteristics of the Exposure variables in East African refugee camps in 2016

Independent Variables	Number of observations (n)	mean/proportion	95% Conf. Intervals (CI)
Mixed origin of Refugees	50	0.36	0.23-0.51
Camp Age	49	13.1	9.1-17.0
CU5 in the camp	47	0.21	0.17-0.26
Health Utilization rate (HU)(New Visits/refugee/year)	47	1.64	1.33-1.96
Host Population Consultations	47	0.16	0.11-0.20
Average number of liters of potable water available per person per day	49	20.4	18.9-21.9
A number of persons of concern per water tap.	43	191.5	104.3-279.0
Households collecting drinking water from protected water sources only	43	0.99	0.97-0.999
Households with sufficient daily water storage capacity	43	0.62	0.53-0.70
Refugees per Latrine	48	17.0	11.9-22.1
Households with drop-hole latrine	42	0.54	0.44-0.65
Households reporting defecating in a toilet	43	0.92	0.90-0.95

Table 4-4. Univariate analysis for selected Demographics, Access and Utilization, Water, Sanitation and Hygiene (WASH) indicators for Incidence of watery Diarrhea among CU5 across East African refugee camps in 2016

Exposure variables	Coefficient	P-Value
Mixed origin of Refugees	-0.0061	0.65
Camp Age.	0.0004	0.1
CU5 in the camp.	0.0735	0.01*
Health Utilization(HU) rate (New Visits/refugee/year)	-0.0049	0.00*
Host Population Consultations.	0.0373	0.1
Average number of liters of potable water available per person per day.	-0.0007	0.1
A number of persons of concern per water tap.	0.0044	0.03*
Households with sufficient daily water storage capacity.	-00.019	0.03*
Refugees per Latrine.	-0.0122	0.2
Households with drop-hole latrine.	-0.0135	0.07
Households reporting defecating in a toilet.	-0.044	0.1

Note: *p<0.05
Values shown in each cell are unstandardized coefficients

Table 4-5. Multivariate Analysis of Incidence of Watery Diarrheal among CU5 across East African refugee camps in 2016 with respect to Demographics, Access, and Utilization, Water, Sanitation and Hygiene (WASH) indicators

Exposure variables	Coefficient	P-Value
Camp Age.	0.03	0.2
CU5 in the camp.	0.8	0.002*
Health Utilization(HU) rate (New Visits/refugee/year)	-0.6	0.03*
Host Population Consultations.	0.03	0.9
Average number of liters of potable water available per person per day.	0.005	0.9
A number of persons of concern per water tap.	0.002	0.2
Households with sufficient daily water storage capacity.	0.04	0.9
Households with drop-hole latrine.	0.05	0.9
Households reporting defecating in a toilet.	-0.1	0.6

Note: *p<0.05

Values shown in each cell are unstandardized coefficients

Table 4-6. Sample size of the multivariate significant variables by hosting refugee countries

Exposure variable	Ethiopia	Kenya	South Sudan	Uganda
Mean incidence among CU5 sample size (n)	23	7	8	9
Mean proportion for CU5 sample size (n)	23	7	8	9
Mean HU rate sample size (n)	23	7	8	9
Mean number of persons of concern per water tap sample size (n)	23	7	5	8
Mean refugees per latrine sample size (n)	23	7	8	10
Mean of the proportion of households reporting defecating in a toilet sample size (n)	23	7	5	8

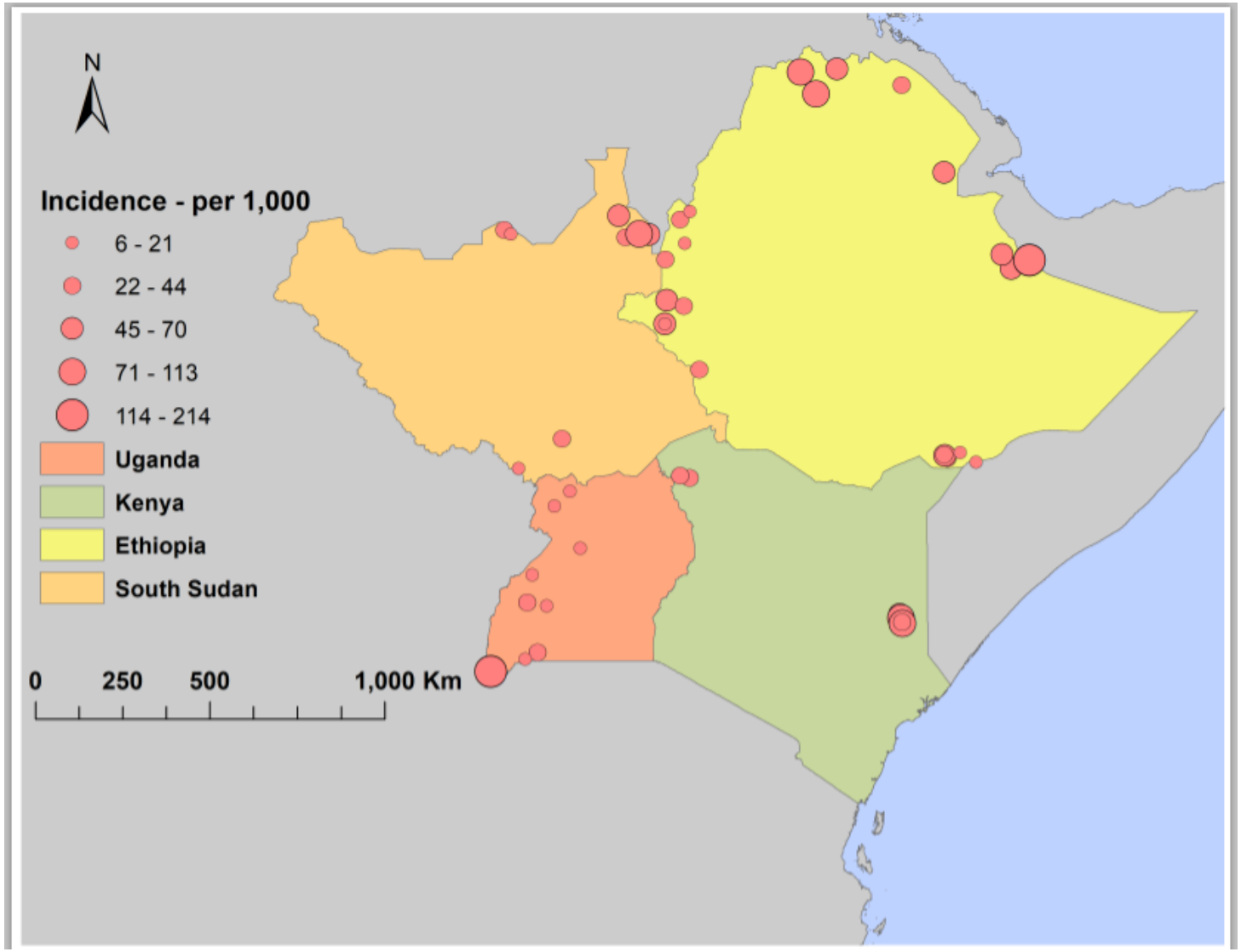

Figure 4-1. Locations of camps with data on the incidence of watery diarrhea (cases per 1,000/CU5/month) in CU5 in East African refugee camps in 2016.

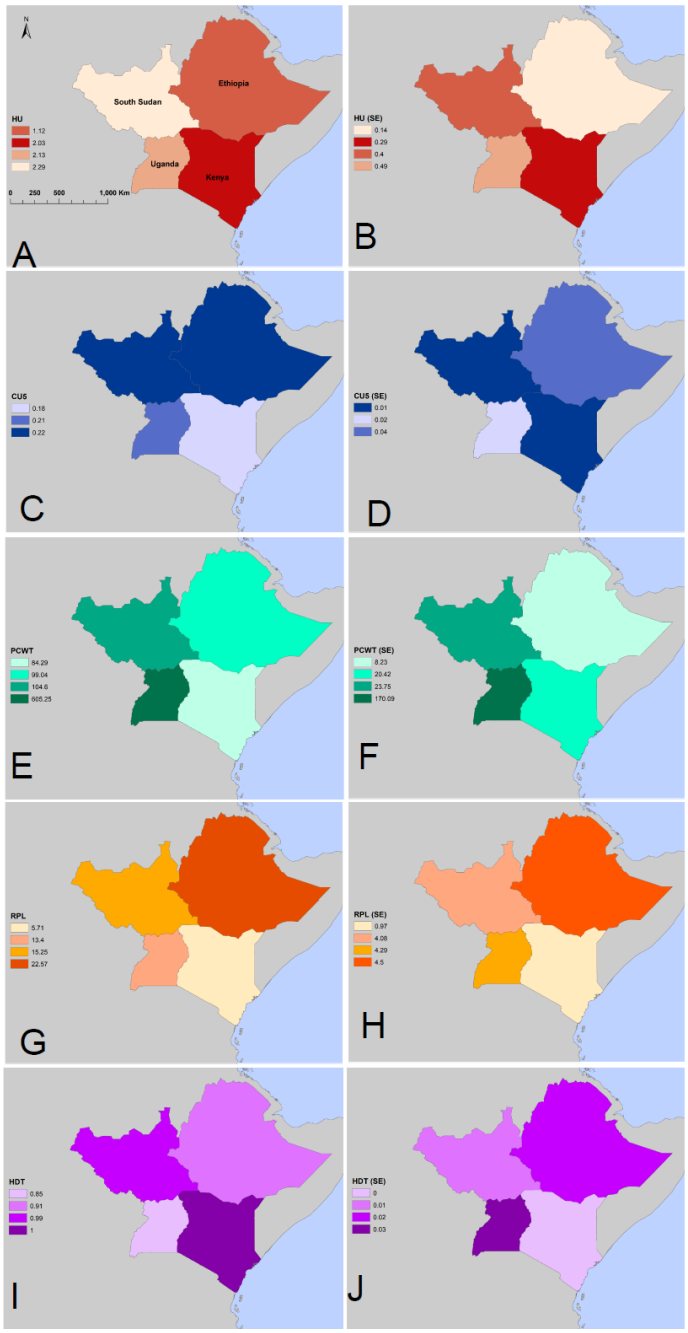

Figure 4-2 The mean and the Standard Error (SE) for the multivariate model significant variables that were associated with incidence of watery diarrheal among CU5 in East African Refugee camps by hosting -refugee countries in 2016. A is the average mean of Health Utilization (HU) rate, B is Standard Error (SE) of (HU) of the mean, C. is the average mean of proportion of Children under Five (CU5), D. is Standard Error (SE) of proportion of CU5 of the mean, E is average mean of Person of Concerns per Water Tap (PCWT), F is Standard Error (SE) of PCWT of the mean, G is average mean of Refugees per Latrine (RPL), H is Standard Error (SE) of RPL of the mean, I is average mean of Households reporting Defecating in the Toilet (HDT, and J is Standard Error (SE) of HDT of the mean.

CHAPTER 5
DISCUSSION AND IMPLICATIONS OF RESEARCH FINDINGS

Discussion

The aims of this study have been to increase understanding, specifically risk factors, for diarrheal disease in an understudied population: refugee children under the age of 5.

In Chapter 2, systematic review of the literature found that lack of clean water; inadequate sanitation, and lack of cleanness at the camp's level were the main drivers of a diarrheal disease among CU5 in the refugee camps. Furthermore, it found that much of this diarrheal disease came from outbreaks. Refugee camps are run by UNHCR, and UNHCR often relies on the prominent supporters such as actresses (i.e., Angelina Jolie), goodwill ambassadors (i.e., Modeler Alex Wek from South Sudan), and high profile supporters (i.e., actor Ben Stiller). When resources are limited (dry up), and UNHCR is unable to provide clean water, adequate sanitation, and hygiene, the incidences of diarrheal disease increase among CU5. As a result, CU5 is most likely to die from the diarrheal disease, despite being a relatively easy disease to cure with modern technology. Since resources are constrained at the camp level, implementing agencies such as IRC, Doctors Without Borders, and Care International who work at the camp level should focus on the provision of sufficient clean water. This may include the need to collaborate and/or share resources including information about WASH conditions.

Having identified the seemingly self-evident risk factors for diarrheal disease in refugee camps, those being risk factors related hygiene and sanitation conditions, the outcome of the systematic review of literature in Chapter 2 was

used to examine the primary risk factors for diarrheal disease among CU5 in East African refugee camps in subsequent analysis.

The analysis of the UNHCR HIS morbidity and mortality data, this research found a much higher incidence of watery diarrhea among CU5 compared to incidence of bloody diarrheal from 2006-2016. This finding is not unexpected, given that watery diarrhea is much more prevalent than bloody diarrhea in the general population, however, the findings underscore a need for decision makers and program implementing partners within refugee camps to put additional effort into prevention and management of watery diarrhea. If these agencies were able to invest additional resources into molecular testing to further define the cases of watery diarrhea and bloody provided additional recommendations might be evident. For example it has been documented in literature that CU5 are susceptible to diarrheal pathogens such as: viral agents (*Rotavirus, Adenovirus, Norovirus*), protozoa agents (*Giardia lamblia, Entamoeba Histolytica, Cryptosporidium parvum*), bacterial agents (*Enteroaggregative Escherichia coli, Shiga-toxigenic Escherichia coli, Enteropathogenic Escherichia coli,Enterotoxigenic Escherichia coli, Shigella, Salmonella*), and soil-transmitted helminthes (*Ascaris lumbricoides, trichuris trichiura, ancylostoma duodenale, necator Americans*). In refugee camps, robust data about incidence and prevalence of pathogen-specific among CU5 are lacking.

Establishing laboratory to examine the etiology of diarrheal pathogen-specific among CU5 in refugee camps would dramatically increase our understanding of the current situation. In addition, given that the incidence of watery of diarrheal was found to be prevalent among newly established camps

from 2006-2016, a pilot study on diarrheal disease among CU5 in East African refugee camps that are established from 2017 on forward would contribute additional understanding to the vulnerability certain populations.

Final elements of increased understanding came from the multivariate analysis conducted in Chapter 4. That analysis indicated that camps with a greater proportion of CU5 are positively associated with increased incidence of diarrheal disease. Given that, according to UNHCR 51% of refugees worldwide are children under the age of 18 years old, it is important to recognize that camps with high rates of young children are increasing at risk for diarrheal disease among those children. Importantly, however, this multivariate regression also indicates that the more CU5 utilize health services at the camp level, the lower the incidence of watery diarrhea. These findings serve to reinforce the message that although increased proportions of children within camps may increase the monthly incidence rate, this risk may be offset by utilization of health facilities by CU5, Thus agencies may be interested in investigating factors that facilitate or inhibit health-seeking behaviors within the camps.

Outside Information about the author lived experienced

It is important to contextualize the author's perspective, which may offer additional insight into interpretation of findings. At the age of six, the authored travelled over 2,000 miles to escape a brutal civil war in South Sudan that claimed his family, the journey ending in an overcrowded Kenyan refugee camp. From the author's experience, an important factor in understanding diarrheal disease among CU5 is the conflict that displaces these children into neighboring countries. Once the conflict or war breaks out in the country of origin, these

children are forced to flee either with parents or with a caregiver, in the case of children being separated from their families, which is common within war zones. Among the numerous difficulties that children living in refugee camps must face, many of these children arrive in poor health condition – malnourished and psychologically traumatized – making them increasingly vulnerable to diarrheal disease and continued nutritional complexities once, they are in the camp.

In the refugee camps, there is minimal variety in the diet due to the food ration constraints. In the normal camp, the food is distributed according to the number of the people at the household at level. For example, if a household has five children, these children are given a ration of lentil, wheat flower, potatoes etc. In UNHCR food ration, meat is not distributed, leaving CU5 with insufficient daily dietary intake. In developed countries, diarrheal disease is not an enormous problem compared to refugee camps, and CU5 should not be dying of communicable disease such as diarrheal when we know there are protective factors we can deploy against this disease. It is time for the developed and developing nations to work together to mitigate the risk of diarrheal disease among CU5 in the refugee camps.

What is missing in HIS datasets

There were definitely constraints to this research given the nature of the UNHCR HIS data set. UNHCR and its partners have been collecting the HIS data since 2006, but data are collected at the camp level by month. The ability to understand the health situation of children within the camps would be dramatically improved if the data were collected at the individual level. Collecting diarrheal morbidity and mortality data among CU5 in the refugee camps at the

household level would significantly increase the ability for researchers to engage the data in scholarly publications, thus increasing research and understanding of the understudied subject of refugee health. Individual level data though costly will provide essential information to form a robust data set, providing meaningful information to improve child health outcomes through the camps.

Recommendations for Future Research

The HIS data has some limitations, as described in Chapter 3. For the future studies, the author recommends seeking the qualitative approach to address the gaps in HIS Data. Also, this qualitative approach should be conducted among camps with a higher prevalence of incidence watery diarrheal in CU5. This research should examine the etiology of diarrheal pathogen-specific among CU5 in East African refugee camps, as justified by the gap in knowledge identified in the HIS Data. This research will be significant because no such epidemiological study, to the knowledge of the researcher has been conducted among CU5 in East African refugee camps. The following research aims should be explored for further studies:

- Describe the etiology of enteric infections associated with diarrheal disease in CU5 in East African refugee camps.
- Test the relationship between risk factors operating at multiple levels (e.g., individual, household, and community levels) and enteric infections in CU5 in East African refugee camps.
- Compare etiologies of enteric infections among groups, particularly by country of origin (nationality), among CU5 in East African refugee camps.
- Determine the cost of treating diarrhea, and how this may impact the financial and social well-being of the household among CU5 in East African refugee camps.

- Determine whether the cost of treating previous diarrheal episodes affect future healthcare treatment for subsequent diarrheal episodes or other illnesses among CU5 in East African refugee camps.

- Determine the spatiotemporal dynamics of diarrheal occurrence, severity (blood in stool), mortality and morbidity, and determine what ecological (climate, temperature), demographic (influx of new refugees), or social (cultural practices, WASH behavior) risk factors are associated with these patterns among CU5 in East African refugee camps.

Having reviewed the findings of each chapter and recommendations for future research, the researcher now turned to those broader implications of the research.

Who can benefits from this research findings

Characterization of risk factors, morbidity, and mortality associated with CU5 across East African refugee camps should be of interests research to the UNHCR and its implementing agencies with potential for drawing operational conclusions and formulating programmatic recommendations. There are numerous potential stakeholders and decision makers who may utilize findings from this study. A description of stakeholders is provided below at various levels:

1. Individual and Community level- a characterization of risk factors, morbidity, and mortality associated with diarrheal disease will provide physicians or healthcare providers at health facilities in refugee camps the information necessary to effectively manage cases. This will improve the health outcome of individuals (both the CU5 and others) protect communities from potential diarrheal outbreaks by targeting effective treatments of case and prevention strategies throughout refugee camps in East African refugee host-countries.

2. Health partner and UN agency levels-improved information regarding risk factors, morbidity, and mortality associated with CU5 in the East Africans Refugee camps will help planners and managers more effectively allocate limit resources toward effective prevention and treatment efforts.

3. UNHCR (Headquarters) level- an improved understanding of the risk factors, morbidity, and mortality associated with CU5 in East African Refugee camps will allow donors and the Ministries of Health (MOH) to

develop more effective strategic policy, advocacy, and resource mobilization efforts for improved health outcomes.

Our findings of diarrheal disease among CU5 living in refugee camps may provide insights into risk factors for diarrheal disease among the entire East African refugee camps or community. This study helps us to have a better understanding about the burden of diarrheal disease in CU5 years old, which may be applicable in refugee camps across other parts of the world.

APPENDIX A
CHECKLIST OF ITEMS TO INCLUDE WHEN REPORTING A SYSTEMATIC REVIEW

Table A-1. Checklist of items to include when reporting a systematic review.

Section/topic	#	Checklist Item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in the systematic review, and, if applicable, included in the meta-analysis).	
Data collection process	10	Describe the method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	

Table A-1. Continued

Section/topic	#	Checklist Item	Reported on page #
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing the risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, the difference in means).	
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	
Risk of bias across studies	15	Specify any assessment of the risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on the risk of bias of each study and, if available, any outcome-level assessment (see item 12).	
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of the risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	

Table A-1. Continued

Section/topic	#	Checklist Item	Reported on page #
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policymakers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., the risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., the supply of data); the role of funders for the systematic review.	

APPENDIX B
FULL DETAILS OF THE SEARCH STRATEGIES FOR SYSTEMATIC REVIEW

Research Question

What are the existing risk factors and etiology of diarrheal disease in the refugee camps or Internally Displaced Camps?

Inclusion Criteria

- Publication types**:** scholarly peer-reviewed (where possible) journal articles
- Article types: (clinical trials, meta-analyses, systematic reviews, observational studies??? OR all types, since this is such a narrowly focused study (yay!) but that may not have a lot published on it)
- Language**:** full text in English language only.
- Publication date**:** Past 20 years-1996 to 2016.
- The population studied**:** Residents that live in the Refugee or Internal Displaced Camps.
- Has to be humans species
- (EXAMPLE: -Journals, conference proceedings, workshops, dissertations/thesis, reports, commentaries, and case studies -English language only
- Past 10 years (2004-2014)
- Populations studied
- Must be (age, gender, race, ethnic background socioeconomic status, occupation…)
- _____ name of health phenomenon) must occur in or around___(geographic area)

Exclusion Criteria:

- Publication types**:** personal communications, popular press articles, editorials, letters, comments.
- Languages**:** Full text in language other than English
- Publication dates**:** Before 1996 and 2016
- Populations studied: nonresident that does not live in the Refugee or Internal Displaced Camps.

- Languages other than English
- Before 2004 or after 2014
- Populations studied are from North America, Europe, Japan, Australia, or New Zealand
- Research on _____
- _____ from outside factors not related to (location in last item of Inclusion criteria—this from an infectious disease search, so may not apply to your search)

Term Harvesting- PubMed database 1

Concept	Risk factors	Etiology	Diarrheal diseases	Refugee place
MeSH Subject Terms (non-major)	"Risk Factors"[MeSH] OR "Sanitation"[Mesh] OR "Maternal-Child Health Services"[Mesh] OR "Child Health Services"[Mesh] OR "Community Health Services"[Mesh] OR "Health Services Accessibility"[Mesh] OR "Breast Feeding"[Mesh] OR "Malnutrition"[Mesh] OR "Toilet Facilities"[Mesh] OR "Nutritional Status"[Mesh]	"Etiology"[Subheading] OR "Causality"[MeSH Terms] OR "Cholera"[Mesh] OR "Shigella"[Mesh] OR "Rotavirus"[Mesh] OR "Norwalk virus"[Mesh] OR "Salmonella"[Mesh] OR "Enterotoxigenic Escherichia coli"[Mesh] OR "Gastroenteritis"[Mesh]	"diarrhea"[MeSH Terms] OR "dysentery"[MeSH Terms] OR "Cholera"[Mesh]	("Refugees"[MeSH Terms] **AND camp*)**
Keywords	“risk factor” OR “risk factors” OR “nutrition status” OR malnutrition OR sanitation OR latrine* OR	etiology OR etiologic OR etiolog* OR aetiolog* OR cause OR causes OR causality OR	diarrhea* OR diarrhea* OR dysentery OR cholera OR “bloody stool” OR	"refugee camp" OR "refugee camps" OR "displaced persons camp" OR "displaced

Concept	Risk factors	Etiology	Diarrheal diseases	Refugee place
	“community toilet” OR “community toilets” OR “food insecurity” “access to health services” OR “access to health service” OR “access to health clinic” OR “access to health clinics” OR “health service utilization” OR “health services utilization” OR “utilization of health services” OR “use of health services” OR “health services use” OR “oral hydration” OR “breast feeding”	shigella OR “Norwalk virus” OR “Norwalk viruses” OR rotavirus OR rotavituses OR salmonella OR “Enterotoxigenic Escherichia coli" OR “Enterotoxigenic E. coli" OR “ETEC” OR gastroenteritis OR cholera	“watery stool” OR “loose stool”	persons camps" OR ((refugee* OR “asylum seeker” OR “asylum seekers” OR “displaced person” OR “displaced persons” OR "displaced people" OR "displaced population" OR “stateless person” OR “stateless persons” OR “stateless people” "displaced populations" OR “internally displaced” OR “conflict displaced” OR “forcibly displaced” OR “enforced displacement” “internal displacement”) AND (camp OR camps OR “tent city” OR “tent cities”))

Concept 1: risk factor or risk factors, causality, Causalities

Concept 2: etiology, aetiology

Concept 3: diarrhea, diarrhoea, dysentery,

Concept 4: Refugee, Refugees, asylum seeker, asylum seekers, displaced person displaced persona, displaced people and stateless person, stateless persons

Concept 5: Internal displaced Camp, Internally Displaced Camps, “tent city” OR “tent cities”

Pull all my search terms for each concept together

- **Concept 1:** ((("risk factor"[MeSH Terms] OR "Risk Factors"[MeSH Terms OR "causality"[MeSH Terms] OR Risk factor OR Risk factor* OR causality OR Causalit*)
- **Concept 2**: AND ("etiology"[Subheading] OR “etiolog*” OR “aetiolog*) AND ("diarrhea"[MeSH Terms] OR "dysentery"[MeSH Terms] OR “diarrhea” OR diarrhoe” OR dysentery”)
- **Concept 3**: And ("refugees"[MeSH Terms] OR "emigrants and immigrants"[MeSH Terms]OR “refugee*” OR “asylum seeker*” OR “displaced person*” OR “emigrant*” OR “immigrant*”)
- **Concept 4**:AND “internal displaced camp” OR Internal displaced camp*”).

Term Harvesting- Database 2 (heading applies to Web of Science aka WOS)

Concept	Concept 1	Concept 2	Concept 3	Concept 4
Keywords				

WOS Categories (disciplines) used to limit/refine search

Term Harvesting- Database CABI 3

Concept	Concept 1	Concept 2	Concept 3	Concept 4
CABICODEs				
Key Words				

Database Name: PubMed

- PubMed (44 articles)– Medicine, nursing, dentistry, veterinary medicine, the preclinical sciences, nutrition, delivery of health care, pharmacology, environmental health, pathology, toxicology, biochemistry, genetics, molecular biology, and psychiatry.
- Date search conducted: May 24, 2016

Search string

We conducted several searches but here is the final search string for PubMed (44 articles) that we settle with:

(("Risk Factors"[MeSH] OR "Sanitation"[Mesh] OR "Maternal-Child Health Services"[Mesh] OR "Child Health Services"[Mesh] OR "Community Health Services"[Mesh] OR "Health Services Accessibility"[Mesh] OR

"Breast Feeding"[Mesh] OR "Malnutrition"[Mesh] OR "Toilet Facilities"[Mesh] OR "Nutritional Status"[Mesh] OR "risk factor" OR "risk factors" OR "nutrition status" OR "nutritional status" OR "malnutrition" OR "sanitation" OR "latrine*" OR "community toilet" OR "community toilets" OR toilet* OR "food insecurity" OR "access to health service" OR "access to health services" OR "access to a health clinic" OR "access to health clinics" OR "health service utilization" OR "health services utilization" OR "utilization of health services" OR "use of a health service" OR "use of health services" OR "health service use" OR "health service uses" OR "health services use" OR "health services uses" OR "oral hydration" OR "breast feeding" OR "Etiology"[Subheading] OR "Causality"[MeSH Terms] OR "Cholera"[Mesh] OR "Shigella"[Mesh] OR "Rotavirus"[Mesh] OR "Norwalk virus"[Mesh] OR "Salmonella"[Mesh] OR "Enterotoxigenic Escherichia coli"[Mesh] OR "Gastroenteritis"[Mesh] OR "etiology" OR "etiologic" OR "aetiology" OR "aetiologic" OR "cause" OR "causes" OR "causality" OR "shigella" OR "Norwalk virus*" OR "rotavirus" OR "rotaviruses" OR "salmonella" OR "Enterotoxigenic Escherichia coli" OR "Enterotoxigenic E. coli" OR "E. coli" OR "ETEC" OR "gastroenteritis" OR "cholera")) AND ((("diarrhea"[MeSH Terms] OR "dysentery"[MeSH Terms] OR "diarrhea" OR "diarrhoea" OR "diarrheal" OR "diarrhoeal" OR "dysentery" OR "bloody stool" OR "bloody stools" OR "watery stool" OR "watery stools" OR "loose stool" OR "loose stools")) AND ("refugee camp" OR "refugee camps" OR "displaced persons camp" OR "displaced persons camps" OR "internally displaced people camp" OR "internally displaced people camps" OR "IDP camp" OR "IDP camps" OR "Refugees"[MeSH Terms] OR "refugee*" OR "asylum seeker" OR "asylum seekers" OR "displaced person" OR "displaced persons" OR "displaced people" OR "displaced population" OR "displaced populations" OR "stateless person" OR "stateless persons" OR "stateless people" OR "internally displaced" OR "conflict displaced" OR "forcibly displaced" OR "internally displaced")) AND (camp[tiab] OR camps[tiab]) AND (("1996/01/01"[PDat] : "2016/12/31"[PDat]) AND Humans[Mesh]).

Filters activated

- We searched article published in the last 20 years from 1996 to 2016, humans, English.

Results (#)

- 44 articles were found

Database name: Web of Science (WOS) (50 articles)

- Web of Science – consists of 3 databases (in sciences, social sciences, and arts & humanities) that cover journals or primary literature. They are: the sciences, social sciences, and arts & humanities.

Date search conducted

- May 24, 2016

Search string:

TOPIC: ("maternal child health service*" OR "child health service*" OR "community health service*" OR "health services accessibilit*" OR "etiology" OR "etiologic" OR "aetiology" OR "aetiologic" OR "cause*" OR "causality" OR "shigella" OR "Norwalk virus" OR "Norwalk viruses" OR "rotavirus" OR "rotaviruses" OR "salmonella" OR "Enterotoxigenic Escherichia coli" OR "Enterotoxigenic E. coli" OR "ETEC" OR "gastroenteritis" OR "cholera" OR "health services utilization" OR "health service utilization" OR "utilization of health services" OR "use of health service" OR " use of health services" OR "health service uses" OR "health services use" OR "health services uses" OR "oral hydration" OR "breast feeding" OR "risk factor*" OR "malnutrition*" OR "latrine*" OR "community toilet*" OR "toilet*" OR "sanitation" OR "shared toilet*" OR nutritional status OR "nutrition status*" OR "toilet facilit*" OR "stunting" OR "wasting" OR "food insecurity" OR "access to health service" OR "access to health services" OR "access to a health clinic" OR "access to health clinics") *AND* **TOPIC:** ("diarrhea" OR "diarrhoea" OR "diarrheal" OR "diarrhoeal" OR "dysentery" OR "bloody stool*" OR "watery stool*" OR "loose stool*" OR "gastroenteritis") *AND* **TOPIC:** ("refugee camp" OR "refugee camps" OR "displaced persons camp" OR "displaced persons camps" OR "internally displaced people camp" OR "internally displaced people camps" OR "IDP camp" OR "IDP camps" OR "asylum seeker" OR "asylum seekers" OR "displaced person" OR "displaced persons" OR "displaced people" OR "displaced population" OR "displaced populations" OR "stateless person" OR "stateless persons" OR "stateless people" OR "internally displaced" OR "conflict displaced" OR "forcibly displaced" OR "internally displaced").

Filters activated:

- We searched article published in the last 20 years from 1996 to 2016, humans, English.

Results (#) 50 articles were found

Database name:

- CABI (31 articles)

CAB :

- Keep track of every area of agricultural science, veterinary medicine, nutrition and natural resources.
- Date search conducted: March 17, 2016.

Search string:

("maternal child health service*" OR "child health service*" OR "community health service*" OR "health services accessibilit*" OR "etiology" OR "etiologic" OR "aetiology" OR "aetiologic" OR "cause*" OR "causality" OR "shigella" OR "Norwalk virus" OR "Norwalk viruses" OR "rotavirus" OR "rotaviruses" OR "salmonella" OR "Enterotoxigenic Escherichia coli" OR "Enterotoxigenic E. coli" OR "ETEC" OR

"gastroenteritis" OR "cholera" OR "health services utilization" OR "health service utilization" OR "utilization of health services" OR "use of health service" OR " use of health services" OR "health service uses" OR "health services use" OR "health services uses" OR "oral hydration" OR "breast feeding" OR "risk factor*" OR "malnutrition*" OR "latrine*" OR "community toilet*" OR "toilet*" OR "sanitation" OR "shared toilet*" OR nutritional status OR "nutrition status*" OR "toilet facilit*" OR "stunting" OR "wasting" OR "food insecurity" OR "access to health service" OR "access to health services" OR "access to a health clinic" OR "access to health clinics")

AND ("diarrhea" OR "diarrhoea" OR "diarrheal" OR "diarrhoeal" OR "dysentery" OR "bloody stool*" OR "watery stool*" OR "loose stool*" OR "gastroenteritis")

AND ("refugee camp" OR "refugee camps" OR "displaced persons camp" OR "displaced persons camps" OR "internally displaced people camp" OR "internally displaced people camps" OR "IDP camp" OR "IDP camps" OR "asylum seeker" OR "asylum seekers" OR "displaced person" OR "displaced persons" OR "displaced people" OR "displaced population" OR "displaced populations" OR "stateless person" OR "stateless persons" OR "stateless people" OR "internally displaced" OR "conflict displaced" OR "forcibly displaced" OR "internally displaced"). Timespan**:** 1996-2016. Indexes**:** CAB Abstracts.

Filters activated:

- 20 years from 1996 to 2016, humans, English

Results #:

- 31 articles

Summarize of my detailed search strategy into 1-2 sentences for the Methods section within the paper, see below:

Subject headings and truncated, phrase-searched keywords for risk factors, etiology, diarrheal diseases and refugee place were searched in 3 major and widely used databases, PubMed, Web of Science (WOS) and CABI. Results were combined and limited to English-language full-text, humans and publications within the last 20 years (1996 to 2016).

Total # of results (all databases): 125 articles

 # Removed as exact duplicates: 124 Minus 85= 39 articles

Total # abstracts reviewed: 85 articles
 # Excluded for other reasons: 71 articles see below:

- 1. Language that is not English: article by Heraut, L. A: [Miranda de Ebro: Medical condition of the concentration camp in the autumn of 1943], it was in French.

- 2. Language that is not English: article by Ivanoff and Chaignat (2002), title "[Anticholera vaccines and vaccination].

- 3. Book section by WHO title: Communicable disease epidemiological profile: Cote d'Ivoire-2010.

- 4. Systematic Review: Heijnen, M et al, article title: Shared Sanitation Versus Individual Household Latrines: A systematic Review of Health Outcomes

- 5. A systematic Review article by De Buck, E. et al (2015) title: **"**A Systematic Review of the Amount of Water per Person per Day Needed to Prevent Morbidity and Mortality in (Post-)Disaster Settings".

- **6.** This article only talks about Mnigococcal meningitis and not mentioning anything about risk factors or the etiology of diarrheal disease at all. So we excluded this article by Heyman et al (1998) title **"**Meningococcal meningitis among Rwandan refugees: diagnosis, management, and outcome in a field hospital".

- **7.** Review Article: title **"**Infectious diseases of severe weather-related and flood-related natural disasters"by Ivers et al, 2006.

- **8.** Language that is not English: article by Meijman, H. J et al title "Physicians without borders and diarrhea as a cause of illness and death in refugee camps", it was in dutch.

- **9.** Systematic review article by Ramesh, A et al, 2015, title "Evidence on the Effectiveness of Water, Sanitation, and Hygiene (WASH) Interventions on Health Outcomes in Humanitarian Crises: A Systematic Review".

- **10.** Full text not only, the Prehospital and Disaster Medicine want me to buy the article, title "Mortality and morbidity among Rwandan refugees repatriated from Zaire, November, 1996" by Banatvala, N. et al, 1998.

- **11.** Language that is not English: article by Berner, W, 2008, title **"**History of the control of acute infectious diseases in Poland after the World War I - until the year 1924 (including big cities)", it was in polis language.

- **12.** This article by Chaloner et al (1996), title "Paediatric rectal prolapse in Rwanda" does not talk about the risk factors or the etiology of diarrheal disease in children in the refugee settings, so we excluded.

- **13.** Article by Chiabi, A et al (2016), title “Health campaign for children in catastrophic situations: the case of a Central African refugee camp at Gado-Badzere in the East Region of Cameroon” full text is not online.

- **14.** Article by Cronin, A. A et al (2008), title “A review of water and sanitation provision in refugee camps in association with selected health and nutrition indicators--the need for integrated service provision” is a review, so we will the article excluded from the study.

- **15.** Full text not online for this article **“**Emergence of vector-borne diseases during war and conflict” by Faulde M, 2006.

- **16.** Excluded because it is a review article tittle **“**Verocytotoxic diarrhogenic bacteria and food and water contamination in developing countries: a challenge to the scientific and health community” by Doughari et al, 2010.

- **17.** Full text not online for this article **“**Caring for Myanmar refugees in Thailand” by Fox and Kumchum-1996.

- **18**. Article title “Electrocardiographic enigma of a classical disease: pellagra” by Kavitha et al was excluded because it is irrelevant to our research questions and it is a short report.

- **19.** This article**, “**Infectious disease outbreaks in centralized homes for asylum seekers in Germany from 2004-2014” by Kuhne and Gilsdorf was excluded because it was not in English language, it is in German.

- **20.** This article **“**SURGERY AND REFUGEE POPULATIONS” by Kushner et al, 2009 was excluded because it is a review.

- **21.** This book section by Lionetti et al, title **“**Coeliac disease in Saharawi children in Algerian refugee camps” was excluded because no full text online and it is a book section.

- **22.** This article **“**Disaggregation of health and nutrition indicators by age and gender in Dadaab refugee camps, Kenya” by Mark H full text is not available online is this is why it is excluded.

- **23**. This article **“**Rotavirus-associated diarrhoea in children in a refugee camp in Jordan” by Nimri and Hijazi, 1996 does not have a full text online, so we excluded the article.

- **24.** This article **“**Morbidity and mortality amongst southern Sudanese in Koboko refugee camps, Arua district, Uganda” by Orach-1999 does not have a full text online.

- **25.** This article **"**Control of infectious diseases in refugee and displaced populations in developing countries" by Paquet and Hanquet-1998 is a review and this is why it is excluded.

- **26.** This article **"**A single dose of live oral cholera vaccine CVD 103-HgR is safe and immunogenic in HIV-infected and HIV-noninfected adults in Mali" by Perry et al, 1998 is irrelevant to our research question of Risk Factors and etiology of diarrhea disease in the refugee camp.

- **27.**This article **"**Sanitation and physical disability: challenges to latrine access in Kakuma refugee camp, Kenya" by Wasonga and Bukania is not available online so it was excluded.

Article to keep are in green background:

- Red=articles that might be excluded and see below because, the article doesn't talk about risk factors or the etiology of diarrheal disease:

- 28. Malnutrition and micronutrient deficiencies among Bhutanese refugee children--Nepal, 2007

- 29. Ali, S. et al, 2015: Effectiveness of emergency water treatment practices in refugee camps in South Sudan.

- 30. Biran et al, 2012: Hygiene and sanitation practices amongst residents of three long-term refugee camps in Thailand, Ethiopia and Kenya.

- 31. Butler et al, 2013: Point of use water treatment with forward osmosis for emergency relief.

- 32. Chen et al: Hypovolemic shock and metabolic acidosis in a refugee secondary to O1 serotype Vibrio cholerae enteritis.

- 33. Connolly M.A et al: Communicable diseases in complex emergencies: impact and challenges, excluded because it is a review.

- 34.Cronin, A.A.: Quantifying the burden of disease associated with inadequate provision of water and sanitation in selected sub-Saharan refugee camps, it is a review, good for introduction.

- 35. Crooks A.t. and Hailegiorgis, A.B, 2014: An agent-based modeling approach applied to the spread of cholera

- 36. Farmer et al: Meeting Cholera's Challenge to Haiti and the World: A Joint Statement on Cholera Prevention and Care.

- 37. Hassan et al-1997: Factors associated with anemia in refugee children because, it only talks about anemia

- 38. Husain et al-2015: A pilot study of a portable hand washing station for recently displaced refugees during an acute emergency in Benishangul-Gumuz Regional State, Ethiopia, this article only talks about soap but no mentioned of known risk factors or etiology of Diarrheal disease in the refugee camps.

- 39. Jee Hyun et al-2012: Program experience with micronutrient powders and current evidence, this was excluded because it does not address the research question.

- 40. Kalluri, P et al-2006: Evaluation of three rapid diagnostic tests for cholera: does the skill level of the technician matter?. This article was excluded because it doesn't contain the research question being ask.

- 41. Kiulia, N. M et al-2014: Norovirus GII.17 Predominates in Selected Surface Water Sources in Kenya. This article is excluded because it does not answer the research question.

- 42. Lim, J. H et al-2005: Medical needs of tsunami disaster refugee camps, this article was excluded because it only talks about medical needs assessment but does not address the research question.

- 43. Magloire, R et al-2010: Rapid establishment of an internally displaced persons disease surveillance system after an earthquake - Haiti, 2010, it is just about surveillance and does not mentioned risk factors or etiology of diarrheal disease.

- 44. Moss, W. J et al-2006: Child health in complex emergencies, this article was excluded from with study because, they "reviewed published literature.

- 45. Noji, E. K-2006-ABC of conflict and disaster - Public health in the aftermath of disasters, this article was excluded because it does not answer the research question; risk factors and etiology of diarrheal disease in the refugee camps.

- 46. Palacio, H et al: Norovirus outbreak among evacuees from Hurricane Katrina - Houston, Texas, September 2005, this article will be excluded because it doesn't not fit into IDPs or Refugee camps but, it is good for discussions section.

- 47. Qayum, M et al-2011: Bathing and cleaning practices in the camp of Jalozai Pakistan, for internally displaced people, based on Sphere Standards and Indicators, this article was excluded because it does not answer the research question.

- 48. Rosewell, A et al-2013: Concurrent Outbreaks of Cholera and Peripheral Neuropathy Associated with High Mortality among Persons Internally Displaced by a Volcanic Eruption, this article is excluded because it does not answer the research question.

- 49. Saeed, I. E and Ahmed, E. S-2003: Determinants of malaria mortality among displaced people in Khartoum state, Sudan, this article is excluded because it does not address the research question.

- 50. Salama, P et al-2004: Lessons learned from complex emergencies over past decade, this article was excluded because it is a literature review.

- 51. Sami, L-2011: Starvation, Disease and Death: Explaining Famine Mortality in Madras 1876-1878, this article was excluded because it does not answer the research question.

- 52. Sugunan, A. P et al-Outbreak of rotaviral diarrhoea in a relief camp for tsunami victims at Car Nicobar Island, India, this article is excluded because it was a short report and it doesn't answer the research question.

- 53.Todd et al-2007: Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 2. Description of outbreaks by size, severity, and settings, this article was excluded because it is a literature review.

- 54. Toole, M. J and Waldman, R. J-1997: The public health aspects of complex emergencies and refugee situations, this article is excluded because it does not answer the research question.

- 55. Walden, V. M et al-2005-Container contamination as a possible source of a diarrhoea outbreak in Abou Shouk camp, Darfur province, Sudan, this article is excluded because it doesn't answer the research questions.

- 56. An article published by WHO: Epidemic-prone disease surveillance and response after the tsunami in Aceh Province, Indonesia in 2005 was excluded from this study because it doesn't address the core research question (risk factors and etiology).

- 57.An article by Chaicumpa, W. et al-1998: Rapid diagnosis of cholera caused by Vibrio cholerae O139 was excluded because it does not address the research question.

- 58. An article by Dalahmeh, S. and

- Assayed, A-2008: : Health risk assessment of children exposed to greywater in Jerash refugee camp in Jordan) was excluded because it does not address the research question.

- 59. An article by Davis, A. P: Targeting the vulnerable in emergency situations: who is vulnerable? -1996 was excluded because it does not answer the research question.

- 60. An article Degomme, O. and Guha-Sapir, D: Patterns of mortality rates in Darfur conflict-2010 was excluded because it does not answer the research questions.

- 61. Article by Elsanousi, S et al-A study of the use and impacts of LifeStraw in a settlement camp in southern Gezira, Sudan was excluded because it does not address the research question.

- 62. Article by Fredrick, T et al-2015: Cholera Outbreak Linked with Lack of Safe Water Supply Following a Tropical Cyclone in Pondicherry, India, 2012 was excluded because it does not address the research question, hint (Tropical Cyclone).

- 63. Article by Grandesso, F et al-2005: Mortality and malnutrition among populations living in South Darfur, Sudan: results of 3 surveys, September 2004 was excluded because does not address the research question, hint-mortality and malnutrition.

- 64. Article by Grandesso, F et al-2014: Risk factors for cholera transmission in Haiti during inter-peak periods: insights to improve current control strategies from two case-control studies was excluded because it does not address the research question, hint (Earthquake in Haiti).

- 65. Article by Grein, T et al-2003: Mortality among displaced former UNITA members and their families in Angola: a retrospective cluster survey was excluded because it does not address the research question, hint (this article talk about mortality).

- 66.Article by 2009: Malnutrition and Mortality Patterns among Internally Displaced and Non-Displaced Population Living in a Camp, a Village or a Town in Eastern Chad was excluded because it does not address the research questions, hint (Malnutrtional and Mortality).

- 67. Article by Gupta, S. K et al-2007: Factors associated with E-coli contamination of household drinking water among tsunami and earthquake survivors, Indonesia was excluded because it does not address the research question, hint-(tsunami and earthquake).

- 68. Article by Jayatissa, R et al-2006-Assessment of nutritional status of children under five years of age, pregnant women, and lactating women living in relief camps after the tsunami in Sri Lanka was excluded because it does not address the research question, hint (tsunami).

- 69 Article by Pinto, A et al -2005: Setting up an early warning system for epidemic-prone diseases in Darfur: a participative approach was excluded because it does not address the research question, hint (i.e early warning system).

- 70 Article Polonsky, J. A et al-2013: High levels of mortality, malnutrition, and measles, among recently-displaced Somali refugees in Dagahaley camp, Dadaab

refugee camp complex, Kenya, 2011 was excluded because it does not answer the research question, hint (mortality, malnutrition and Measles).

- 71. Article by Spiegel, P et al et al-2002: Health programmes and policies associated with decreased mortality in displaced people in postemergency phase camps: a retrospective study was excluded because it does not address the research question, hint(i.e., programmes policies and mortality).

- 72. Benny, E. et al-2014: A large outbreak of shigellosis commencing in an internally displaced population, Papua New Guinea, 2013.

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- This article **"**Program Experience with Micronutrient Powders and Current Evidence" is duplicate, this was discover during the screening and identification process.

Article to keep are:

- 1. Abu Elamreen et al, 2008: Isolation and antibiotic susceptibility of Salmonella and Shigella strains isolated from children in Gaza, Palestine from 1999 to 2006.

- 2. Abu Mourad, T. A, 2004: Palestinian refugee conditions associated with intestinal parasites and diarrhoea: Nuseirat refugee camp as a case study.

- 3. Abu-Alrub, S. M. et al, 2014: A large outbreak of shigellosis commencing in an internally displaced population, Papua New Guinea, 2013.

- 4. Doocy, S and Burnham, 2006: Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia.

- 5. Hershey et al-2011: Incidence and risk factors for malaria, pneumonia and diarrhea in children under 5 in UNHCR refugee camps: a retrospective study.

- 6. Issa et et al:2015: Access to safe water and personal hygiene practices in the Kulandia Refugee Camp (Jerusalem).

- 7. Kerneis, S et al-2009: A Look Back at an Ongoing Problem: Shigella dysenteriae Type 1 Epidemics in Refugee Settings in Central Africa (1993-1995).

- 8. Mahamud, A. S et al-2012: Epidemic cholera in Kakuma Refugee Camp, Kenya, 2009: the importance of sanitation and soap.

- 9.Mohamed, A. H et al-2014: Health care utilization for acute illnesses in an urban setting with a refugee population in Nairobi, Kenya: a cross-sectional survey.

- 10. Peterson et al-1998-The effect of soap distribution on diarrhoea: Nyamithuthu Refugee Camp.

- 11.Roberts et al-2001: Keeping clean water clean in a Malawi refugee camp: a randomized intervention trial.
- 12. Shultz A. et al:2009: Cholera Outbreak in Kenyan Refugee Camp: Risk Factors for Illness and Importance of Sanitation
- 13. Swerdlow D. L et a: Epidemic cholera among refugees in Malawi, Africa: treatment and transmission.

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4. UNHCR. *Convention and Protocol-Relating to the Status of Refugees* [cited 2017 5/23/2017]; Available from: http://www.unhcr.org/en-us/3b66c2aa10.

5. UNHCR. *Global Trends-Forced Displacement in 2016*. 2017 [cited 2017 10-13-2017]; Available from: http://www.unhcr.org/en-us/statistics/unhcrstats/5943e8a34/global-trends-forced-displacement-2016.html.

6. UNHCR. *Global Appeal 2017 Update* 2017 2017 [cited 2017 5/23/2017]; Available from: http://reporting.unhcr.org/sites/default/files/ga2017/pdf/GA_2017%20Update%20Eng_Book_low-res.pdf.

7. Liu, L., et al., *Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000.* The Lancet, 2012. **379**(9832): p. 2151-2161.

8. Kotloff, K.L., et al., *Burden and aetiology of diarrhoeal disease in infants and young children in developing countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study.* Lancet, 2013. **382**(9888): p. 209-222.

9. UNHCR. *UNHCR Global Trends Forced Displacement in 2014* 2014 [cited 2015 September 24]; Available from: http://unhcr.org/556725e69.html.

10. Paquet, C. and G. Hanquet, *Control of infectious diseases in refugee and displaced populations in developing countries.* Bulletin de l'Institut Pasteur, 1998. **96**(1): p. 3-14.

11. Hershey, C.L., et al., *Incidence and risk factors for malaria, pneumonia and diarrhea in children under 5 in UNHCR refugee camps: a retrospective study.* Confl Health, 2011. **5**(1): p. 24.

12. Boru, W.G., et al., *Aetiology and factors associated with bacterial diarrhoeal diseases amongst urban refugee children in Eastleigh, Kenya: a case control study: original research.* African Journal of Laboratory Medicine, 2013. **2**(1): p. 1-6.

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BIOGRAPHICAL SKETCH

Jacob Atem received a Bachelor of Arts degree in Pre-Medicine/Biology from Spring Arbor University in 2008 and a Master of Public Health from Michigan State University in 2010. He received his Ph.D. from the University of Florida in the fall of 2017. He spent most of his life as one of the original Lost Boys of South Sudan. He is the President and Chief Executive Officer (CEO) of Southern Sudan Healthcare Organization (SSHCO) from 2008-present. To read more about Jacob's story, "*A Tale of Personal Tragedy and Trial*" here is the link: http://www.sshco.org/about-founders.html [69].