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Zoonotic Diseases in Refugee or Internally Displaced Person Camps:

A Scoping Review

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Abstract Cover Page

Zoonotic Diseases in Refugee or Internally Displaced Person Camps:

A Scoping Review

By

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Bachelor of Science in Biomedical Sciences
Marquette University
2011

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An abstract of
Zoonotic Disease in Refugee or Internally Displaced Person Camps: A Scoping Review
A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health in Global Health
2017

Abstract

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A Scoping Review

By Grace Wedad Goryoka

Introduction: Emerging and re-emerging zoonotic diseases pose an increasing threat to public health and global health security. 61% of infectious and 75% of emerging diseases affecting humans are zoonotic in nature. With over 63 million people around the world today either forcibly displaced or refugees, the number of refugee or displaced person camps continues to grow. Population movement of humans and livestock, increased habitat overlap with wildlife, poor sanitation and hygiene conditions, and low vaccination rates in camp or conflict settings are known risk factors for communicable and likely zoonotic disease transmission. We conducted a scoping review to describe the extent and importance of zoonotic diseases in camp-like settings.

Methods: We conducted a comprehensive literature search in 5 databases for articles that mentioned a case or suspected case of zoonotic disease specifically in displaced populations or people in camp or conflict settings. Articles were screened for relevance and key characteristics were extracted if included. We excluded mosquito-borne disease articles.

Results: The literature search yielded 579 articles. Of the 70 articles that met inclusion criteria, 57% highlighted parasitic zoonoses, 34% highlighted bacterial zoonoses, 29% highlighted viral zoonoses, and 4% highlighted zoonotic injury. 27 different zoonoses and 1 condition were reported within these articles. 15 articles excluded, for not reporting any human zoonoses cases, identified either zoonoses positive animals or non-mosquito vectors in camp settings.

Discussion: Zoonoses are present within camps and conflict settings. Given that 18% of zoonoses identified are notifiable under the International Health Regulations and 28.5% are considered bioterrorism agents, the nature and associated risk of the zoonoses seen within camp settings is significant and may be further intensified in these vulnerable populations and camp conditions. Further review of the current guidance documents revealed gaps for how to adequately address zoonotic disease risk in camp-like settings. Management of zoonoses within camps requires an interdisciplinary One Health approach to help mitigate and control zoonoses within camp settings.

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Table of Contents

Abbreviations

ARI	Acute Respiratory Infection
CCHF	Crimean Congo Hemorrhagic Fever
CDC	Centers for Disease Control and Prevention
CHE	Complex Humanitarian Emergency
ERRB	Emergency Recovery and Response Branch
EWARN	Early Warning Alert and Response Network
FAO	Food and Agriculture Organization
HAT	Human African Trypanosomiasis
HIS	Health Information System
HIV	Human Immuno-deficiency Virus
IDP	Internally Displaced Person
IHR	International Health Regulations
IOM	International Organization for Migration
LEGS	Livestock Emergency Guidelines and Standards
MSF	Médecins Sans Frontières
NARE	Needs Assessment for Refugee Emergencies
OHCHR	UN High Commissioner for Human Rights
OIE	World Organisation for Animal Health
PPE	Personal Protective Equipment
RVF	Rift Valley Fever
SME	Subject Matter Expert
UN	United Nations
UNAIDS	Joint UN Programme on HIV/AIDS
UNDP	United Nations Development Program
UNHCR	United Nations High Commission of Refugees
UNICEF	United Nations Children's Fund
VWB	Veterinarians Without Borders
WFP	World Food Programme
WHO	World Health Organization

Chapter 1. Introduction

With over 63 million people around the world today either forcibly displaced or refugees, the amount of resettlement and number of refugee camps continues to grow across the world [1]. The United Nations High Commission for Refugees (UNHCR) alone, has reported a staggering increase in refugees or forcibly displaced populations over the last ten years and this is mainly due to war and persecution [1]. Refugees, or people who have left their home country, and internally displaced populations (IDPs), people who have been displaced from their homes and have relocated to another area within their home country, may have left their homes due to war, conflict, persecution, civil strife, political instability and/or natural or technological disasters. Following emergencies, affected populations are often displaced and temporarily resettled in camps by UNHCR or disperse among the local population. UNHCR is part of the United Nations and their primary responsibility is to "safeguard the rights and well-being of people who have been forced to flee", which includes refugees, returnees, stateless people, the internally displaced, and asylum seekers [2]. UNHCR is responsible for providing critical emergency assistance during times of displacement, particularly focusing on protection and shelter needs, and camp coordination and management. [2, 3]. The International Organization for Migration (IOM) is another United Nations (UN) agency that has a mandate for working with displaces populations and humanitarian emergencies [4]. Other UN agencies are also involved in working with displaced populations and humanitarian emergencies by utilizing a cluster approach where each agency takes the lead within their particular area of expertise [3].

During complex emergencies, the greatest health concerns for refugees or IDPs are diarrheal diseases, malaria, acute respiratory infections, measles, malnutrition, and other infectious diseases due to high rates of mortality [5]. Other concerns that attribute to disease spread within camp-settings are overcrowding, lack of access to clean water, poor sanitation and hygiene facilities, lack of access to nutritious foods, and low or absent vaccine coverage [6-8]. Due to these concerns, refugee and IDP

camps address communicable disease prevention by focusing on provision of preventative and curative medical services, clean water and proper sanitation, site planning, mass vaccination against highly communicable disease, sufficient food supply, and vector control [9].

Mass population movements to areas of less conflict and more forested areas can expose people to animal populations, both wildlife and domestic species, which can cause a greater risk of zoonotic disease [10]. Livestock (ex. cows, goats, sheep, poultry, swine and rabbits), specifically, play an integral role in human society, particularly in developing countries, and this is maintained in refugee or IDP camps [11, 12]. Refugees and IDPs may bring their livestock along with them to these resettlement camps. These domesticated animals brought and kept in or near many refugee resettlements can lead to both positive and negative social, economic, and environmental implications [13].

While livestock play an integral role in society and camp-like settings, livestock can also contribute to significant health risks if not managed properly. Within the least developed countries in the world, it is estimated that 25% of the infectious disease are from zoonotic disease, diseases spread between animals and people [14]. Additionally it is estimated that 12% of infectious diseases within developing countries are zoonotic diseases that are transferred from livestock through food consumption, vectors or direct contact [15]. Due to the close proximity and interactions between humans and livestock in camp settings along with environmental stressors associated with of refugee camps (high population density, lack of water, sanitation and basic healthcare) there are increased risks of transmission of zoonotic diseases to humans which may result in outbreaks of infectious diseases in humans. Human cases of zoonotic diseases linked to livestock like Brucellosis, Hepatitis E, Q fever, and Crimean Congo Hemorrhagic Fever have been reported in camps, conflict settings or within displaced populations. [16-19]

Aside from livestock being a reservoir for zoonotic diseases, wildlife and free-roaming domestic animals also pose risks of zoonotic disease transmission in camp-like settings. Human cases of

monkeypox, Marburg, Ebola virus, rabies, have been found within camp settings or refugee or IDP populations [10, 20-22]. Vector-borne diseases, like malaria, have also contributed to the morbidity and mortality within camp setting. 30% of malarial deaths in Africa are from countries that have been affected by complex emergencies [23]. Additionally non-mosquito vector sources have also played a role in zoonotic disease transmission within these settings. Cases of Lassa fever, tularemia and plague have been documented from rodents and cases of murine and scrub typhus, leishmaniasis (visceral and cutaneous), and Human African Trypanosomiasis have been reported from other vectors [24-32].

Several guidance documents have been created to address animal husbandry and wildlife management in the Complex Humanitarian Emergency (CHE) setting. For instance, UNHCR has created a handbook for improved livestock management called *UNHCR Livestock-Keeping and Animal Husbandry in Refugee and Returnee Situations* to provide managers and those working in specific refugee operations "the most appropriate forms of livestock keeping and management" [33]. Additionally, the Livestock Emergency Guidelines and Standards (LEGS) Project has developed a LEGS handbook which provides standards and guidelines "for appropriate and timely livestock-based livelihoods responses in emergencies, using a participatory and evidence-based approach" [12]. While LEGS also addresses some components of wildlife and other domestic species, its primary focus is on livestock interventions for those affected by humanitarian crises. The LEGS handbook is a companion to the SPHERE handbook, which is "an internationally recognized sets of common principles and universal minimum standards in life-saving areas of humanitarian response" [34]. The UNHCR and LEGS handbooks focus primarily on livestock management in camps, whereas, the SPHERE handbook focuses primarily on human health in emergency settings.

While guidance documents like LEGS and UNHCR's animal husbandry handbook are available to highlight risk factors of zoonotic diseases in emergency settings, no known information or tools have yet been adapted to be used to assess the level of risk of zoonotic diseases in camp-settings. The findings

from this scoping review aims to highlight the gaps in knowledge and will be used to develop or adapt briefings and tools to aid Public Health officers to assess the risk of zoonotic diseases and help prevent zoonotic disease outbreaks in camp settings, as well as, recommendations to integrate their detection and response plans into existing outbreak detection and surveillance systems, like Early Warning and Response Network (EWARN) and Health Information System (HIS).

Objective:

To conduct a scoping review of the literature to highlight any available information regarding the risk of zoonotic disease transmission in refugee or internally displaced persons camps.

Aims:

1. Assess the importance of zoonotic diseases in complex emergencies, with special reference to refugee or IDP settings
2. Summarize current recommendations on risk assessment, detection and response to zoonotic diseases in camp settings
3. Generate preliminary guidelines and a recommendations for a risk assessment tool to assess risk of zoonotic diseases in camp settings

Chapter 2: Comprehensive Review of the Literature

Emerging and re-emerging zoonotic diseases continue to pose an increasing threat to public health and global health security. Zoonotic diseases defined by the World Health Organization (WHO) as "any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa" can be prevented, but health systems around the world have not yet prioritized prevention and control efforts for these diseases, leaving them as significant threats to public health [13]. Zoonotic diseases make up 61% of all infectious diseases and over 75% of emerging pathogens affecting humans [35]. Various factors contribute to the increase of zoonotic infectious diseases, worldwide. Globalization and increased commerce and international trade have continued to bring people closer; climate and geophysical changes have resulted in unpredictable distributions of arthropod vectors; migration has resulted in overcrowding; and humans encroaching closer to wildlife habitats have all contributed to the emergence or re-emergence of zoonotic disease. These factors, as well as, social, behavioral, and cultural factors, will continue to play a role in future zoonotic disease threats [36, 37].

Zoonotic diseases have varying incidence rates and some can cause significant morbidity and mortality. For example, dog-mediated rabies results in greater than 95% of the human rabies deaths across the world, around 59,000 persons each year, with a nearly 100% case fatality rate [38-40]. In comparison, brucellosis has a low mortality rate of around 2% or less for untreated cases but can cause chronic debilitating issues contributing to a higher morbidity [41]. Certain populations may be more susceptible to zoonotic disease infection like populations handling and working closely with animals, like veterinarians, scientists working with zoonotic pathogens, farmers, pastoralists, and those living in close proximity of livestock and/or wildlife, like refugees or internally displaced populations, are considered high risk for zoonotic disease transmission. In this paper, we will focus primarily on the risks associated with zoonotic disease in refugee or internally displaced populations.

Increased conflict, persecution, political instability, and natural or technological disasters over the last decade has led to a significant increase in refugees, people who have left their home country and have entered into another country to flee from political, persecution, and internally displaced persons (IDPs), people who have been displaced from their homes and have relocated to another area within their home country, around the world [1]. Complex humanitarian emergencies (CHEs) are disasters that combine multiple contributing factors of a disaster and typically follow war, conflict, and political instability [42]. CHEs, war, conflict, political instability, and natural and man-made disasters have led to mass migration and population displacement. The United Nations High Commissioner of Refugees (UNHCR) has estimated that at the end of 2015, 65.3 million people around the world were forcibly displaced, leaving people taking shelter in temporary settlements or camps, with overcrowding, rudimentary shelter, inadequate safe water and sanitation, and increased exposure to infectious disease outbreaks [1, 43]. These multiple factors make refugees and internally displaced populations one of the largest groups of vulnerable populations around the world. Following emergencies, affected populations are often displaced and temporarily resettled in camps by UNHCR or become dispersed among the local population. UNHCR is a program of the United Nations and their primary responsibility is to "safeguard the rights and well-being of people who have been forced to flee", which includes refugees, returnees, stateless people, the internally displaced, and asylum seekers [2]. UNHCR is responsible for providing critical emergency assistance during times of displacement, particularly focusing on protection and shelter needs, and camp coordination and management. [2, 3]. The International Organization for Migration (IOM) is another United Nations (UN) agency that has a mandate for working with displaces populations and humanitarian emergencies [4]. Other UN agencies like the Joint UN Programme on HIV/AIDS, Office for the Coordination of Humanitarian Affairs, Office of the United Nations High Commissioner for Human Rights (OHCHR), UN Development Programme, United Nations Population Fund, UN Children's Fund, World Food Programme, World Health Organization, UN Volunteers are

also involved in working with displaced populations and humanitarian emergencies by utilizing a cluster approach where each agency takes the lead within their particular area of expertise [3].

While many organizations and agencies provide humanitarian assistance in complex humanitarian emergencies, public health and veterinary services during these emergencies need further support to investigate zoonoses [8]. Due to the growing amount of people displaced from their homes and settling in refugee camps worldwide, combined with the fact that 75% of emerging pathogens are zoonotic, further research is needed to help assess the risk of zoonotic disease transmission in camp settings [35, 44].

While the incidence of zoonotic diseases in camp-like settings is unknown, various factors in these settings can increase the risk of an individuals or community's susceptibility to infectious diseases communicable disease and zoonotic disease transmission, These factors can be biological, environmental, social, cultural, and economic[37]. In refugee camps, communicable disease prevention focuses on provision of basic medical services, clean water and proper sanitation, site planning, mass vaccination against highly communicable disease, sufficient food supply, and vector control [9].

Shelters in camp settings vary depending on the acuteness of the emergency from having no materials to build shelters thus being completely exposed to the outside elements, to plastic sheeting, tents, or to small cement homes [45]. Camp settings are often overcrowded and damp, which can lead to an increased risk of disease transmission and poor health outcomes [45]. In the Jalazone refugee camp in Palestine, studies show that over 60% of households had high-density living, defined as 3-5 people per room, and that 16.5% of the households were overcrowded, with more than 5 people per room [6]. In al-Amari camp in Palestine, 68% were living in high density households and 12.8% were in overcrowded households [45]. Additionally, a study conducted in Sri Lanka showed that IDPs from the 2004 Asian tsunami that were living in transitional camps compared to those living in permanent housing projects had self-reported significantly worse health outcomes [46]. Aside from shelter conditions, refugees and

displaced populations continue to be at an increased risk for infectious diseases when they are surrounded by poor water and sanitation conditions. A study looking at health data from refugee camps in 2005 in seven countries in sub-Saharan Africa, Ethiopia, Kenya, Tanzania, Zambia, Sierra Leone, Democratic Republic of Congo, and the Republic of Congo, reported that 132,088 of 149,721 (88%) cases of diarrhea were attributed to poor water and sanitation conditions[7].

In complex emergencies, most deaths are attributed to communicable diseases [47]. Diarrheal infections, acute respiratory infections, malaria, measles, and malnutrition are some factors that contribute to deaths in complex emergencies. Over 40% of the deaths that occur during an acute phase of an emergency are attributed to diarrheal deaths, with children under 2 years old being the most heavily affected [8]. The most common source of infection has been contaminated water sources, soap scarcity, and food contamination [8]. Acute respiratory infections (ARIs) in complex emergencies are amplified in these camp-like settings due to overcrowding, inadequate shelter and blankets, and smoke inhalation from indoor fires. ARIs attribute to significant morbidity and mortality in camps, yet few studies have identified specific pathogens attributing to this burden [8]. While strong efforts have been made in refugee and IDP camps to provide adequate health, shelter, food, water, sanitation, and hygiene services, many challenges still exist. Inadequate infrastructure, staff capacity, supplies, and funding, political insecurity, safety, and poor coordination affect the delivery of services and care to displaced populations. These challenges continue to affect the management, control, and treatment of communicable and infectious diseases in camp settings.

Comorbidities, stress, and immunodeficiency are also risk factors for contracting communicable diseases and increased severity of illness [48-52]. Malnutrition, and chronic diseases like diabetes, hypertension, and HIV all affect refugees and displaced persons. In a Syrian refugee camp in Jordan, more than half of the households surveyed had at least one family member in the household with the presence of diabetes, cardiovascular disease, and/or hypertension [53]. In a study looking at Somalian,

Iraqi, and Bhutanese refugees, refugees were found to have a significantly increased risk for diabetes compared to non-refugee immigrant controls [54]. Another phenomenon occurring in camps is the double burden of malnutrition and obesity. A study looking at women and children in four western Sahara refugee camps in Algeria found that about 25% of the households sampled were found to have women and children both overweight and undernourished [55]. Non-communicable disease in camp settings is a growing trend and increases individual's susceptibly to infectious diseases [56]. Poor nutrition and low or absent vaccine coverage can also increase or exacerbate communicable diseases, particularly in children and infants [8].

Additionally, due to increasing population density and urbanization, the human population has further encroached into wildlife habitats. This increased habitat overlap between wildlife and humans further puts humans at risk for zoonotic disease transmission because these animals may be a reservoir of infectious agents [57]. The overlapping habitat puts naïve populations, both humans and other animals, at risk due to the animal reservoir having a high prevalence of the pathogen and then transfers over to the naïve population, a concept known as "spillover" [58]. Spillover events increase the risk of zoonotic disease transmission, especially with populations, like refugees or IDPs, who are continuing to live in areas in close proximity to wildlife populations. An example of a spillover event is the Rift Valley Fever outbreak that occurred in the Horn of Africa Region in 2007. Driving factors of disease transmission to non-affected areas were related to population and livestock movement due to political, civil, and food insecurity and crowded environments of refugee settlements [59]. Additionally, spillover events have also occurred in Brazil in a current yellow fever outbreak that is maintained by a sylvatic cycle involving non-human primates and mosquitos within Brazil. The population living in these areas where transmission is occurring are areas that have varying vaccination coverage rates or were previously considered to be low risk areas and yellow fever vaccination was not included within the childhood immunization schedule [60]. The wavering of vaccine coverage has continued to increase the

risk or the spill over to the human population, which can also pose a risk to displaced populations that have low or absent vaccination coverage [8].

Depending on the size of the camp and how long the camp has been established, wet markets may be present in camp settings. Wet markets typically consist of vendors selling live animals or fresh meat, including poultry, beef, or pork. Live markets in camps can put humans directly at risk for zoonotic disease transmission due to close interaction with animals, lack of personal protective equipment (PPE) and disinfectant, and non-enforced food safety protocols. Slaughtering practices and lack of PPE and refrigeration can increase not only the butcher's risk of zoonotic disease consumption, but also the consumers within these camps and the surrounding resident populations that camp markets serve. Live poultry markets have been linked to zoonotic avian influenza infection in humans, yet effective interventions in live poultry markets can reduce zoonotic disease risk from avian influenza [61, 62]. A cross-sectional study conducted in China looked at the air quality in live poultry markets to assess the potential for airborne or fomite transmission. This study found that viral loads are high in the air and the environment in live poultry markets and poultry workers within these markets are constantly exposed [63]. Additionally, the World Food Programme conducts market assessments in refugee camps that focus on food security (availability and adequate access at all times to sufficient, safe, nutritious food)[64] and economic livelihood. In Al Za'atari refugee camp in Jordan, one market assessment stated that five vendors were selling live animals at the market, but does not mention what the conditions of these markets were like [65]. Dadaab and Kakuma refugee camps in Kenya have also had market assessments highlighting that live animal markets occurred in both refugee camps. Livestock were typically purchased outside of the camps and animal slaughtering occurs in public slaughterhouses at both Dadaab and Kakuma where the meat is sold in kiosks, shops, or open air outlets [66]. Because all of these risk factors make individuals in camp-settings more susceptible to infectious disease, there is a great need to minimize the risk of infectious disease transmission within these settings.

Zoonoses has been observed in camp settings for many years. Vector-borne diseases, like malaria, have contributed to the morbidity and mortality within camp setting. 30% of malarial deaths in Africa are from countries that have been affected by complex emergencies [23]. Malaria control in complex emergencies poses challenges due to the breakdown of healthcare infrastructure, population migration of non-immune people to endemic areas, and high population concentration [67]. Because of the need and importance for vector control in emergencies, due to the high mortality rates of malaria in camp and conflict settings, multiple agencies and organization have developed vector control guidance documents, particularly on mosquito control for malaria in CHEs. As there are preexisting resources for mosquito control in complex emergencies, the aim for this scoping review focuses on zoonotic disease risk from domestic and wild animals as well as non-mosquito vector sources (eg. rodents, sand flies, fleas) seen in refugees, IDPs, or camp settings.

Livestock play a significant role in the livelihood of people and is considered a large financial and social asset for many[11]. This is no different in camps, where some refugees or displaced populations have been able to bring their livestock or domestic animals with them. The types of animals that are seen on refugee camps vary depending on geographical location, but the most commonly seen in refugee settings are cattle, goats, sheep, poultry, pigs, and camels. Some examples of zoonotic diseases that can be transmitted from these species include Brucellosis, Salmonella, Rabies, Cystocercosis, and Leptospirosis [33]. Due to the close proximity of owners and their livestock in camp-settings, zoonotic disease transmission risk within these populations is high. In 2016, a Syrian refugee, who was a sheepherder, migrated to Germany and was diagnosed and confirmed to have *Brucella melitensis [16]*. A research study currently being conducted aims at estimating the role of Brucellosis among fever patients in refugee camps where they hypothesize that up to “5% of fever patients have acute brucellosis” [68]. Additionally, poultry serves as not only a food source for refugees, but also as a source of economic development. Live markets in camp-settings are an additional risk of zoonotic disease

transmission. In 2006, avian influenza in poultry had entered Sudan and threatened refugee camps in Sudan affected by the Darfur crisis [69]. Avian influenza and swine influenza outbreaks can rapidly spread through camps due to the overcrowding of humans and animals.

Aside from livestock, wildlife and free-roaming domestic animals can continue to put people in camp settings at an increased risk to zoonotic disease transmission. Rabies cases or risks of rabies in camp or conflict settings have also been associated with free-roaming or wild dogs in 3 countries [22, 70, 71]. Cases of human monkey pox were identified in refugees from the Democratic Republic of Congo who had fled to the Republic of Congo [72]. Makeshift shelters and poor food and water storage containers in camp-settings also pose a significant risk for rodent transmission of diseases. Multiple refugee camps in Guinea and Sierra Leone have found active cases of Lassa virus from the *Mastomys natalensis* rat [24, 73]. Cases of plague have also been seen in refugee camps in Vietnam [74]. Endemic Typhus transmitted by lice, found in settings where living conditions are crowded and unsanitary, has been seen in refugee camp settings in Burundi, Russia, Mexico, and Uganda [75-78]. Scrub and murine typhus infections have also been seen on the Thai side of the Thai-Cambodian border, where the displaced Khmer people were living in temporary settlements [79]. Zoonotic disease in camp settings, affecting refugee, or IDP populations continue to be a threat to the health of these vulnerable populations. Additionally, zoonotic diseases are not only a public health threat to displaced populations, but can also threaten those populations surrounding camps and by extension, the rest of the world. Because of the aforementioned concerns of zoonotic disease within camp settings, the objective of this review is to highlight the gap in available information regarding the risk of zoonotic disease transmission in refugee or internally displaced persons camps.

Chapter 3. Manuscript

Title Page

Zoonotic Diseases in Refugee Camps or Internally Displaced Person Camps: A Scoping Review

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Abstract

Introduction: Emerging and re-emerging zoonotic diseases pose an increasing threat to public health and global health security. 61% of infectious and 75% of emerging diseases affecting humans are zoonotic in nature. With over 63 million people around the world today either forcibly displaced or refugees, the number of refugee or displaced person camps continues to grow. Population movement of humans and livestock, increased habitat overlap with wildlife, poor sanitation and hygiene conditions, and low vaccination rates in camp or conflict settings are known risk factors for communicable and likely zoonotic disease transmission. We conducted a scoping review to describe the extent and importance of zoonotic diseases in camp-like settings.

Methods: We conducted a comprehensive literature search in 5 databases for articles that mentioned a case or suspected case of zoonotic disease specifically in displaced populations or people in camp or conflict settings. Articles were screened for relevance and key characteristics were extracted if included. We excluded mosquito-borne disease articles.

Results: The literature search yielded 579 articles. Of the 70 articles that met inclusion criteria, 57% highlighted parasitic zoonoses, 34% highlighted bacterial zoonoses, 29% highlighted viral zoonoses, and 4% highlighted zoonotic injury. 27 different zoonoses and 1 condition were reported within these articles. 15 articles excluded, for not reporting any human zoonoses cases, identified either zoonoses positive animals or non-mosquito vectors in camp settings.

Discussion: Zoonoses are present within camps and conflict settings. Given that 18% of zoonoses identified are notifiable under the International Health Regulations and 28.5% are considered bioterrorism agents, the nature and associated risk of the zoonoses seen within camp settings is significant and may be further intensified in these vulnerable populations and camp conditions. Further review of the current guidance documents revealed gaps for how to adequately address zoonotic disease risk in camp-like settings. Management of zoonoses within camps requires an interdisciplinary One Health approach to help mitigate and control zoonoses within camp settings.

Keywords

Zoonoses, zoonotic disease, refugees, internally displaced person, IDP, refugee camp, camp, conflict

Background

Emerging and re-emerging zoonotic diseases continue to pose an increasing threat to public health and global health security. Zoonotic diseases are defined by the World Health Organization (WHO) as "any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa"[13]. Many zoonotic diseases can be prevented, but health systems around the world have not yet prioritized prevention and control efforts for these diseases, leaving them as significant threats to public health [13]. Zoonotic diseases make up 61% of all infectious diseases and over 75% of emerging infectious diseases affecting humans [35]. Various factors contribute to the increased transmission of zoonotic infectious diseases, worldwide. Globalization, increased commerce, and international trade continue to bring people closer; climate and geophysical changes have resulted in unpredictable distributions of arthropod vectors; migration has resulted in overcrowding and humans encroaching closer to wildlife habitats have all contributed to the emergence or re-emergence of zoonotic disease. These factors, as well as, social, behavioral, and cultural factors, continue to play a role in future zoonotic disease threats [36, 37].

Zoonotic diseases have varying incidence rates and some can cause significant morbidity and mortality throughout the world. For example, dog-mediated rabies causes greater than 95% of the human rabies deaths across the world, around 59,000 people each year, with a nearly 100% case fatality rate [38-40]. In comparison, brucellosis has a low mortality rate of around 2% for untreated cases, but can cause chronic debilitating issues contributing to a higher morbidity [41]. Certain populations may be more susceptible to zoonotic disease infection. These high risk groups include immunologically compromised populations and those handling, working with, or living in close proximity to animals, which is also likely inclusive of refugees or internally displaced populations [80].

Increased conflict, persecution, political instability, and natural or man-made disasters over the last decade have led to a significant increase in refugees, people who have fled their home country to

another country, and internally displaced persons (IDPs), people displaced and relocated within their home country, around the world [1]. Complex humanitarian emergencies (CHEs) are a humanitarian crisis where there is a considerable breakdown resulting from civil conflict and/or foreign aggression which typically lead to mass migration and population displacement [81]. The United Nations High Commissioner of Refugees (UNHCR) has estimated that at the end of 2015, 65.3 million people around the world were forcibly displaced and either dispersed among the local population or are resettled into temporary settlements or camps by UNHCR. UNHCR is a program of the United Nations and their primary responsibility is to "safeguard the rights and well-being of people who have been forced to flee", which includes refugees, returnees, stateless people, the internally displaced, and asylum seekers [2]. UNHCR is responsible for providing critical emergency assistance during times of displacement, particularly focusing on protection and shelter needs, and camp coordination and management. [2, 3]. The International Organization for Migration (IOM) is another United Nations (UN) agency that has a mandate for working with displaces populations and humanitarian emergencies [4]. Other UN agencies are also involved in working with displaced populations and humanitarian emergencies by utilizing a cluster approach where each agency takes the lead within their particular area of expertise [3].
Many camps are overcrowded and have rudimentary shelters, inadequate safe water and sanitation, and increased exposure to infectious disease outbreaks [1, 43]. These camp conditions make refugees and IDPs one of the most vulnerable populations in the world.

During CHEs, the greatest health concerns for refugees or IDPs are diarrheal diseases, malaria, acute respiratory infections, measles, malnutrition, and other infectious diseases [5]. While the incidence of zoonotic diseases in camp-like settings is unknown, various factors in these settings can increase the risk of an individuals or community's susceptibility to infectious and zoonotic diseases. These factors can be biological, environmental, social, cultural, and economic [37]. Other concerns that attribute to disease spread within camp-settings are overcrowding, lack of access to clean water, poor sanitation and

hygiene facilities, malnutrition, and low or absent vaccine coverage [6-8]. Due to these concerns, refugee and IDP camps focus communicable disease prevention efforts on provision of basic medical services, clean water and proper sanitation, site planning, mass vaccination against highly communicable disease, sufficient food supply, and vector control [9].

The growing number of people displaced from their homes and settling in camps worldwide combined with the fact that 75% of emerging diseases are zoonotic, indicates that further research is needed to help assess the risk of zoonotic disease transmission in camp settings [44]. The objective of this scoping review is to describe the extent and importance of zoonotic diseases in refugees, IDPs, or camp-like settings.

Main Text

Review Methodology

We conducted a scoping review in March 2017 to provide evidence of confirmed or suspected zoonoses cases in camp or conflict settings; to highlight any gaps in current recommendations or guidance for zoonoses for camp settings; and to inform the development of recommendations and guidance in camp or conflict settings.

The study population for this scoping review included refugees and internally displaced people, and those that that had been displaced due to conflict, natural, or man-made disaster.

Search Strategy

We reviewed the literature using 5 databases: Medline, Global Health, Scopus, Embase, and Cinahl.

The search was conducted in March 2017 and the search years were:

- Medline: 1946-March 2017
- Global Health: All years

- Scopus: All years
- Embase: 1996-March 2017
- CINAHL: 1982-March 2017

We utilized a search strategy of combination of the following terms:

Population: “Refugee”, “Internally Displaced Person”, “IDP”, “Displaced person”, “Camp”, “Warfare”, “Emergency Shelter”, “Temporary Shelter”, “Shanty Town”, “Tent City”, “displacement”, “resettlement”, “Evacuation facility”, “Humanitarian Emergency”, “Disaster”, “Crisis”, “Armed Conflict”, “War-torn”, “Conflict Region”

AND “Zoonoses”, “Zoonosis”, “Zoonotic”, “Livestock”, “Pet”, “Chicken”, “Cattle”, “Cow”, “Dog”, “Bird”, “Poultry”, “Rodent”, “Rat”, “Pig”, “Swine”, “Bat”, “Camel”, “Horse”, “Equine”, “Shellfish”, “Fish”, “Bovine”, “Donkey”, “Burrow”, “Sheep”, “Goat”, “Monkey”,

AND “Disease”, “virus”, “Infect”, “Bacteria”, “Illness”, “Sickness”, “Fever”

Inclusion/Exclusion Criteria

We included articles in this review if they mentioned a case or suspected case of zoonotic disease specifically in our study population. We excluded articles (Figure 1) if they

- did not discuss a case or suspected case of zoonotic disease (i.e. mentioned diseases or zoonotic diseases, but did not report any cases; mentioned only a non-zoonotic animal disease; or mentioned only the study population, but nothing about zoonotic disease)
- did not include our study population
- focused on war-related concepts (battle injuries, combat, surgical treatment, amputations, weapons, PTSD)

- discussed mosquito-borne diseases, treatment, or intervention (malaria, dengue, yellow fever, bed nets),
- reported zoonotic disease in animals only
- discussed cases or interventions for HIV/AIDS or
- reported zoonotic diseases in non-mosquito vectors only

Mosquito-borne zoonoses were excluded because resources already exist for mosquito control in complex emergencies. Excluded articles where zoonotic disease was only reported in animal or vector populations were still enumerated and reviewed to understand zoonotic disease risk within camp or conflict settings. Articles were classified as duplicates and excluded if cases or suspect cases were the same case reported in different journals or by different authors referencing the same case.

Data Collection and Analysis

Data were abstracted into a Microsoft Excel tool. Variables concerning the zoonotic disease, type of population/camp (refugee, IDP), location, and additional notes were captured. Cases were counted by the number of described case(s) or suspect case(s) from included articles of zoonotic diseases. Articles were classified as duplicates if cases or suspect cases were the same case reported in different journals or by different authors referencing the initial case. Zoonotic diseases were categorized into one topical areas (Bacterial, Zoonotic Injury, Parasitic, and Viral).

Results

OVERVIEW

Our search revealed 579 articles. Articles were broken down by database (Table 1). Eight of the articles were labeled duplicates and excluded, leaving 571 articles for review. The search yielded articles that were published from 1912-2017.

Table 1. Number of Articles in Original Search Listed by Years and Database

Database	Number of Articles	Time Frame of Published Articles
Medline	267	1947-2017
Global Health	157	1912-2017
Scopus	130	1980-2017
Embase	24	1968-2016
CINAHL	1	2016

70 articles met our inclusion criteria (Figure 1). Of the 70 articles, 57% highlighted parasitic diseases, 34% highlighted bacterial diseases, 29% highlighted viral diseases, and 4% highlighted zoonotic injury (Table 2).

Table 2. Number of Articles Included by Category

Category	Total Number of Articles
Parasitic	40
Bacterial	24
Viral	20
Zoonotic Injury	3

*The total number does not match the total number of articles as multiple zoonotic disease cases were mentioned in some articles.

We identified 28 different diseases or conditions (Table 3). Of the 27 zoonotic diseases, 11 were parasitic, 6 were bacterial, and 10 were viral in nature. One condition of zoonotic injury was also listed.

Table 3. Number of Included Articles Categorized by Topic area

Category	Disease or Condition found in articles	Number of Articles
Parasitic (n=40)	Roundworm (Ascariasis, Trichuriasis)	7
	Giardiasis	5
	Human African Trypanosomiasis	5
	Leishmaniasis (Cutaneous and Visceral)	5

	Schistosomiasis	5
	Hookworm	4
	Cysticercosis	4
	Trichinosis	2
	Clonorchiasis	1
	Cryptosporidiosis	1
	Gnathostomiasis	1
Bacterial (n=24)	Typhus (Scrub and Murine)	12
	Plague	4
	Campylobacteriosis	3
	Salmonellosis	3
	Q fever	1
	Tularemia	1
Viral (n=20)	Rabies	5
	Hepatitis E Virus	4
	Viral Hemorrhagic Fever (Crimean Congo, Ebola, Lassa, Marburg)	4
	Monkeypox	3
	Leptospirosis	2
	Rift Valley Fever	1
	Sandfly Fever	1
Zoonotic Injury (n=3)	Dog bite	3
Total*		**87**

*The total number does not match the total number of articles because some articles mentioned multiple zoonotic disease cases

SUMMARY OF ARTICLES BY TOPIC AREA

Parasitic

Roundworm (Ascariasis, Trichuriasis). A study in China looked at North Korean refugees and found that 41% (19/46) of the refugees were positive for *Ascaris lumbricoides* (n=14) or *Trichuris trichiura* (n=11) eggs [82]. In a study looking at parasitic illness in children conducted in slum areas of Brazil, where 27% of the participants were IDPs, found that there was a prevalence of *Trichuris trichiura* (2.1%) and *Ascaris lumbricoides* (1.3%) within the children studied [83]. In an IDP camp in northern Uganda, primary school children were included into a study and found that 6 out of 132 children were positive for *Ascaris lumbricoides and Trichuris trichiura*,[84]. In the Adappamkulam refugee camp in

Sri Lanka, 2 cases of *Ascaris lumbricoides* and 2 cases of *Trichuris trichiura* were found among 159 children displaced by war at the camp [85].

Giardiasis. In the Adappamkulam refugee camp in Sri Lanka, 23 cases of giardia lamblia (14.5%) were found among 159 children displaced by war at the camp [85].

Human African Trypanosomiasis (HAT). A 19 year old refugee from Sudan living in a Ugandan refugee camp was reported to be diagnosed with HAT [32, 86]. A rise in HAT occurred in Kasulu, Tanzania due to resettlement [87]. An epidemic of HAT occurred in the Lawra District of Ghana which was a result of displacement of the people and the abandoning of their villages when someone died, which led to overcrowding, and continued spreading of HAT [88].

Cutaneous and Visceral Leishmaniasis. In a temporary human settlement in the Tedzhen oasis in Turkmen SSR, all people without prior immunity to zoonotic cutaneous leishmanisis (ZCL) living close to a colony of *Rhombomys opimus* gerbils contracted ZCL from sand flies associated with the gerbil burrows - a large percentage of patients being children [29]. In a refugee camp in Pakistan of Afghan refugees, 38% of 9200 inhabitants had active lesions of cutaneous leishmaniasis, while 13% had scars from past lesions [30]. In Huddur, Somalia, visceral leishmaniasis was diagnosed in 230 children living in a camp in the Bakool region who were admitted into a Medecins sans Frontieres center [31].

Schistosomiasis. School children in primary and secondary schools in the Zhaugwe resettlement area of Shurugwi district in Zimbabwe were found to have a prevalence of *S. haematobium* and *S. mansoni* of 68% and 0.2%, respectively [89]. After a flood in 1931 in Hanchuan, China, a laboratory worked in connection with hospitals for population displaced by the flood and found 32 cases of schistosome infection [90]. In northern Uganda, within the Gulu Municipality, 117 out of 132 primary school children studied in an IDP camp were found to have *S. mansoni* [84].

Hookworm. In 2 refugee camps in Uganda with Rwandan refugees, a study conducted in 1967 found that out of 110 specimens examined from schoolchildren within the camps that 51.4% had light hookworm infestation and 5.3% had heavy hookworm infestation [91]. In the Adappamkulam refugee camp in Sri Lanka, 2 cases of hookworm (18.2%) were found among 159 children displaced by war at the camp [85]. In 5 IDP camps in Sierra Leone, hookworm prevalence was at 50% in one of the camps, Parade Ground Camp. Within these 5 camps and among the 581 IDPs, hookworm had a prevalence rate of 18% [92].

Cysticercosis. Refugees at the Thailand-Myanmar border had a prevalence of Cysticercosis of 5.5% indicated by seropositivity. Additionally, pigs within these camps were also checked and they had a prevalence of 3.2% [93]. In 50 Irianese refugees living in camps in Papua New Guinea and 171 other patients not originating from areas that are endemic to *T. solium*, 79 people tested positive for cysticercosis out of the 221 patients with symptoms [94].

Trichinosis. Outbreaks of Trichinellosis occurred in the United States in the 1990s among southeast Asian refugees [95].

Clonorchiasis. In 1946, an outbreak of clonorchiasis broke out among European IDPs in Shanghai. This outbreak was traced back to the consumption of pickled freshwater fish [96].

Cryptosporidiosis. Among 5 IDP camps in Sierra Leone, samples were collected from 178 children below 10 years of age and found that 10% had *C. parvum* and another 5% were infected with both *C. parvum* and *G. lamblia* [92].

Gnathostoma. A 21 year old man from Laos lived in a refugee camp in Thailand before moving to France. In France he was diagnosed with gnathostomiasis, which was assumed to be acquired from eating raw fish during his time in Thailand [97].

Bacterial

Typhus (Scrub and Murine). 14 people displaced from Khmer were clinically diagnosed with murine or endemic typhus at a camp on the Thai-Kampuchean border [98]. An additional article noted that scrub and murine typhus was found within displaced Kampucheans at the Kampuchea-Thai border [99]. A typhus outbreak occurred among refugees from Asia Minor living in Greece in 1923 that had a mortality rate of 7-10% within the refugee population [28]. The Polish-Bolshevik war from 1919-1920 caused people to be displaced and the return of the displaced population back to Poland from Russia contributed to the spread of typhus and other infectious diseases [100]. The largest outbreak of epidemic typhus since World War II was reported in Burundi where ongoing civil war since October 1993 had forced the population to live in makeshift camps [101].

Plague. In a regroupment center in South Vietnam for refugees from North Vietnam, 3 cases of plague were confirmed within this densely populated area [26]. A case of plague was also recorded in July 1950 in a shanty town adjoining a slum township on the outskirts of Johannesburg, South Africa [27].

Campylobacteriosis. In a study looking at primary health care centers in the Gaza strip, 30% of the 133 people included in the study were Palestinian refugees. In this study, 128 stool samples were received of the 133 cases. 3% of the stool samples collected and analyzed tested positive for campylobacter. This study also looked at risk factors for diarrhea within a home and looked at the presence of poultry and rabbits at home. The presence of poultry and rabbits within the home were independently predictive variables for diarrhea [102]. 54 out of 408 Cambodian children with acute diarrhea for less or equal to 3 days who were refugees living in a refugee camp at the Thai-Cambodian border were found to have *Campylobacter jejuni*. Four of 79 children from this same camp with persistent diarrhea, of greater than or equal to 14 days, were diagnosed with campylobacter jejuni. Additionally this study looked at the environmental impacts as well and out of 111 animals at the camp, 6 isolates of campylobacter jejuni were isolated among chickens, cats, and dogs [103].

Salmonellosis. 12 out of 408 Cambodian children with acute diarrhea for less or equal to 3 days who were refugees living in a refugee camp at the Thai-Cambodian border were found to have Salmonella. Six of 79 children from this same camp with persistent diarrhea, of greater than or equal to 14 days, were diagnosed with salmonella. Additionally this study looked at the environmental impacts as well and out of 111 animals at the camp, 2 isolates of salmonella were isolated among cats, and dogs [103].

Q Fever. 654 cases of Q fever, caused by the rickettsial pathogen *Coxeilla burnetti*, were recorded during the time period of the Homeland War in Croatia. While the number of cases decreased after the war compared to prior to the war, the geographical distribution of the disease also changed during this time due to the sheep migrating to a different county for winter grazing [19].

Tularemia. A cluster of patients were reported and clinically confirmed with tularemia in western Kosovo due to years of political crisis and conflict, mass population movements, and poor sanitation and hygiene conditions [25].

Viral

Rabies. After the 2010 earthquake in Haiti, the ministry of health instituted their Internally Displaced Persons Surveillance System (IDPSS) which reported 14 suspected cases of rabies among those that have been displaced [104]. A 10 year old girl, who was a refugee from Vietnam and lived in a camp in Hong Kong for 2 years, died from rabies while living in Australia. She did not contract rabies from living in Australia [105]. In the Krasnador region of Great Sochi, Russia during armed conflict between 1995-1999, 4 people died of rabies after being bitten by free-roaming domestic dogs [106]. In Sierra Leone, there was a significant increase of the incidence of canine-transmitted urban human rabies due to the civil war ($X^2 = 39.63$, $p < 0.0001$), particularly among children ($X^2 = 23.73$, $p < 0.0001$), between 1995 and 2001, [107].

Hepatitis E Virus (HEV). In the Mornay IDP camp in western Darfur, 2621 cases of HEV were recorded and had a case fatality rate of 1.7%. 2 donkeys from the same camp tested positive for HEV [18]. Outbreaks of HEV have also occurred in refugee camps in South Sudan, Somalia, Ethiopia, and Kenya although the zoonotic origin of these outbreaks was not confirmed [108-110].

Viral Hemorrhagic Fever. Outbreaks of Crimean Congo Hemorrhagic Fever occurred during time of social upheaval (immigration and following an earthquake in 2005) with migrations of nomadic people and livestock from Afghanistan to Pakistan [17]. In Gulu, Uganda in 2000, an Ebola outbreak affected groups of IDPs living in slum-like camps [21]. A review of Lassa ward records in the Kenema Government Hospital in Sierra Leone found 90 cases of probable Lassa fever in Liberian refugees living within eight camps in the central to eastern regions of Sierra Leone. Eight of the cases were fatal [111]. An outbreak of Marburg virus occurred during a civil war in the Durba region of the Democratic Republic of Congo between 1998 and 1999. 73 people were infected with Marburg virus and 60 of those people infected died from the disease [20].

Monkeypox. Due to civil conflict within the North and South Kivu provinces of the Democratic Republic of the Congo (DRC), there are over 1.8 million internally displaced persons. Movements of these IDPs to less conflict and more forested areas caused 3 reported cases of monkeypox [112, 113]. Within a population of refugees from DRC living in the Republic of Congo, 10 suspected cases of monkeypox were reported, with two cases being confirmed with laboratory testing [10].

Leptospirosis. In in the nine relevant areas in the vicinity of Ubol-Ratana and Non Wai Dams in northeast Thailand, 12-19% of men and 16-18% of rodents within the settlement and irrigation areas were diagnosed with leptospirosis [114]. In a semi-open refugee camp, Maela, of Burmese refugees in Thailand, a study looking at 203 pregnant women with fever that visited one of the antenatal clinic reported 5 cases of leptospirosis [115].

Rift Valley Fever (RVF). Between 2006 and 2007 a large outbreak occurred in Kenya and Somalia of Rift Valley Fever. 404 human cases were reported and 188 fatalities occurred. Population and livestock movement due to political, civil, and food insecurity were driving factors of disease transmission to non-affected areas, as were crowded environments of refugee settlements. Many were exposed to RVF due to animal slaughter processes and handling of meat [59]. Not all of the cases reported were from people within the camps, but was included because the outbreak was related to a camp.

Sandfly Fever. In 1944-45, an outbreak of sandfly fever occurred after sandflies started breeding profusely in the destroyed Palermo houses where German bombing had occurred [116].

Zoonotic Injury

Dog Bites. With dog-mediated rabies causing greater than 95% of the human rabies deaths across the world, rabies is the primary zoonotic concern associated with dog bites [39]. In Pakistan during the floods in the District Naushahro Feroze, a study collected the incidence rate for bite incidents at temporary relief camps. The study found that bite incidence was 2.6 per 100 person time. Additionally, the study found that only 23% of cases involved dog bites from the victims own dog [117]. In shanty towns in Latin America, many people were being bitten by stray dogs. Some towns were seeing 25% of their population receiving treatment for dog bites [118].

Discussion

We collected and analyzed the literature for the presence of zoonotic diseases in displaced populations and found that cases or suspected cases of zoonotic diseases are present within camp and conflict settings. We found that only 12% of the articles discussed cases or suspected cases of zoonotic disease within our target population. Within these 70 articles, 28 different zoonotic diseases or conditions were reported to be seen in camp or conflict settings within displaced populations.

Just over half of the articles highlighted parasitic infections. Articles discussing soil-transmitted helminths (Ascaris, Trichuriasis, and hookworm) specifically, were greater than 25% of the parasitic diseases reported. Soil-transmitted helminths account for a major burden of disease globally and are found in areas in warm climates where sanitation and hygiene are poor [119]. One of the greatest health concerns for refugees or IDPs are diarrheal diseases [5] and heavy infection of soil transmitted helminths, as well as other parasitic infections reported in this review, can cause diarrhea. These infections can cause serious morbidity within a population, but can also be controlled or eliminated through effective public health interventions [119]. One quarter of the articles were on vector-borne parasitic infections, Human African Trypanosomiasis and Leishmaniasis, that transmit the parasite through either a tsetse fly or a sand fly, respectively [120, 121]. Many of the diseases found within this category are also classified as neglected tropical diseases that are mainly seen in populations living in poverty, with poor sanitation services, and in close contact with domestic animals and livestock [122]. Effective control measures can be achieved through collaborative public health approaches that incorporate animal, human, and environmental health [122].

Half of the articles reviewed in the bacterial category mentioned scrub or murine typhus cases within camps. Rodents, the animal reservoir for scrub and murine typhus [123] and other zoonotic diseases, are found in most camps indicating a possible risk of zoonotic diseases within these settings. Four articles discussed cases of plague, also associated with rodents, which has a mortality rate that can be extremely high if untreated or if not diagnosed [26].

We found that in the viral category, 25% (5/20) of the articles mentioned cases of rabies and 20% (4/20) were diseases causing hemorrhagic fever. In most of the articles that mentioned cases of rabies, dogs were the source of rabies infection and in one article the source of infection was unknown. Since 95% of the human rabies deaths across the world are dog-mediated [39], the risk of displaced populations living among free-roaming dogs further places them at risk for rabies. Dog bites can put

people at an increased risk of rabies transmission, especially among countries that are endemic for rabies. Cases of rabies have been reported among displaced populations and dog bites are also a concern for zoonotic transmission. Additionally, due to limited laboratory resources, some camps may not have the ability to confirm cases of rabies and may only report cases of dog bites. Of the four articles that discussed HEV outbreaks within refugee camps [18, 108-110], on article explicitly tested that two donkey tested positive for HEV highlighting the zoonotic origins for this outbreak [18]. Again further highlighting the need for zoonotic diagnostic capacity within these settings during outbreaks.

While mortality and morbidity rates vary among the 28 zoonotic diseases found within the articles from this scoping review, the zoonotic disease presence and risk in camps and conflict settings is clear. Many of the diseases found within these settings and among displaced populations are diseases that can be controlled or prevented, lowering the risk to these vulnerable populations. Long-term sequela should also not be ignored for zoonoses as recently emerged from animals are responsible for 25% of the DALYs lost to infectious disease and 10% of the total DALYs lost [124], placing a large burden on those affected populations.

Other zoonoses with potential risk

While the inclusion criteria for this scoping review included reporting of only human cases of zoonotic disease within these settings, within the 501 articles excluded, 15 excluded articles reported zoonotic diseases like anthrax, rabies, Lassa virus, parasitic diseases, schistosomiasis, and tick-borne diseases [125-130] in either animal or non-mosquito vector populations highlighting the risk of possible zoonotic disease transmission to humans.

While the literature from this scoping review did not reveal any human cases of avian influenza within camps, avian influenza remains a large threat to camp populations. In 2006, avian influenza in poultry had entered Sudan and threatened refugee camps in Sudan affected by the Darfur crisis [69]. UNHCR

has also developed an emergency preparedness guide for public health officers working within camps. This guidance discusses measures for epidemic preparedness and mentions mitigation measures for avian influenza within camps [131]. Additionally populations in camps with live bird markets are at higher risk for contracting zoonotic disease, as live poultry markets have been linked to zoonotic avian influenza infections in humans [61, 62]. Displaced populations are particularly at risk for influenza and countries need to ensure that refugees and displaced populations are also included within national pandemic preparedness efforts [132].

Brucellosis is another zoonotic disease that poses a public health risk to displaced populations. Globally, brucellosis is one of the most common zoonotic infections[133] and displaced populations can be at risk of contracting brucellosis from consuming raw animal products [134]. Within North Africa and the Middle East, incidence for brucellosis ranged from 52.3 to 268.8 cases per 100,000 person-years between rural and semi-rural areas [135]. While brucellosis has a low mortality rate, severe public health consequences are at risk from the chronic debilitating issues that may occur from disease infection [41].

Cholera outbreaks are a significant public health concern and are a large risk within camp settings [136-138]. While there are no known animal hosts for *Vibrio cholera*, cases of cholera can be contracted from eating raw or undercooked shellfish posing a significant risk to camp populations with access to shellfish [139].

Implication for global health security

Emerging and re-emerging zoonotic diseases continue to pose an increasing threat to public health and global health security. 18% of the diseases listed may classify under a potentially notifiable event under the International Health Regulations (2005) displaying their severity [140]. These diseases may include plague and viral hemorrhagic fevers. Additionally to display the severity of many of the zoonotic diseases that were seen in camps from this review, 28.5% of the diseases listed in this review would

classify under the Centers for Disease Control and Prevention's bioterrorism agent list [141]. Zoonotic diseases pose a serious risk to people living within these camps, in conflict settings, and those living in areas surrounded by camps.

Future Recommendations

Existing Guidance Documents

Current guidance documents have been developed to address animal husbandry, management, and health within camp settings. The *UNHCR Livestock-Keeping and Animal Husbandry in Refugee and Returnee Situations* manual was developed in 2005 and provides managers and those working in specific refugee operations "the most appropriate forms of livestock keeping and management" [33]. While this guidance addresses health risks to humans, guidance needs to be updated to include and further discuss the risk of zoonotic disease from livestock-keeping and animal husbandry practices and address suggested actions camp managers can take to mitigate zoonotic disease risk in camps. Additionally, further realistic recommendations on managing wildlife and domestic animals, including dogs and livestock, in camp settings can possibly be further integrated into the Livestock in Emergencies Guidelines and Standards (LEGS). Medecins Sans Frontieres has also developed a document called "Refugee Health An Approach to Emergency Situations" to guide relief workers regarding operational priorities in CHEs [142]. This guide also mentions that controlling animal reservoirs is needed to control outbreaks, but further guidance needs to be developed to inform relief workers and camp managers on ways to control animal reservoirs of disease. While LEGS focuses primarily on livestock in emergencies, the SPHERE handbook was developed to serve as international guidance for humanitarian assistance. SPHERE encompasses minimum standards that describe "conditions that must be achieved in any humanitarian response in order for disaster-affected populations to survive and recover in stable conditions and with dignity" [34]. SPHERE guidance does not directly address zoonotic disease risk, aside from vector control. Vector control guidance documents heavily focus on mosquito control, but

further guidance needs to be expanded to additional vector sources (rodents, ticks, fleas, and sand flies). While SPHERE discusses that shelter of livestock should not be in the same shelter as where people are, further guidance needs to be developed in conjunction with other organizations developing guidance to incorporate animal management practices at household levels within camps. Additionally, SPHERE guidelines should incorporate further information regarding the risk of zoonotic disease transmission for managing livestock, wild and domestic animals in camp settings. UNHCR's emergency preparedness guide for public health officers should expand beyond the zoonotic disease risk of avian influenza to include other zoonotic diseases of high risk. While guidance documents has been developed for animal husbandry, management, and health within camp settings, these guidance documents should be further updated to incorporate further awareness and prevention of zoonotic diseases.

Surveillance Systems

Within refugee camps the surveillance system that is utilized is Health Information Systems (HIS) which has been developed as a tool for camps to collect, compile, analyze and distribute health information about the health of refugees [143]. During an emergency, a country may choose to implement Early Warning Alert and Response Network (EWARN). EWARN's primary objective is to "rapidly detect and respond to signals that might indicate outbreaks and clusters of epidemic-prone diseases" [144]. While EWARN guidance has incorporated some zoonotic diseases within its framework, further emphasis should be placed on the risk of zoonotic diseases in camps that can cause high morbidity and mortality. EWARN and HIS solely focus on human surveillance. Camp decision makers and public health professionals may want to further incorporate and integrate animal surveillance systems with human surveillance systems to be better prepared to respond to a potential zoonotic disease outbreak. Surveillance systems in camps may not be capturing zoonotic diseases when they are occurring in camps because they either may not be sensitive enough or health systems are not even looking for zoonotic disease. The evidence found regarding zoonotic disease within camps for this review was found from

specific studies or articles and not from routine surveillance data, highlighting the gap in available surveillance data within this subject area. Additionally, surveillance for zoonotic disease can also be implemented into sentinel laboratory systems that have been established in some camps. Surveillance officers should work closely with veterinarians and animal surveillance officers to assess risks within camp settings and further incorporate animal surveillance into human surveillance. This comprehensive surveillance approach may provide public health professionals a more efficient and timely response. Additionally this incorporation of two different surveillance systems will further integrate the animal health and human health sectors. These opportunities for further collaboration can continue to enhance and engage the One Health approach in camp settings.

Enhancing Collaboration

Given that zoonotic diseases can affect both humans and animals, working across human, animal, and environmental health sectors is a critical step in developing optimal prevention and control methods. One Health is the collaborative and multidisciplinary approach that spans across human, animal, and environmental health sectors – at the local, national, regional, and global levels. Given the evidence of zoonotic disease risk within camp settings and no current guidance on how to mitigate this risk, a One Health approach is needed within emergencies and camp settings. Inclusion of local municipality animal health officers, the ministry of agriculture, or non-governmental organizations working within the animal health sector, like Veterinarians Without Borders, and the World Organisation for Animal Health (OIE), is needed to create risk assessments, guidance, and interventions to protect both animal, human and environmental health. Interventions like animal vaccination campaigns or the procurement of vaccinations can be carried out by animal health organizations. If animals are entering camps or affecting camp populations from outside of the camp setting and from the local community, work with the local municipality to take action for vaccination campaigns [71].

Further research and development

LEGS has discussed the risk of zoonotic disease transmission and has developed assessment questions and frameworks for livestock in emergencies, yet no known practical tool has been developed to help assess the risk of zoonotic disease transmission to humans in camps.

Also, since some camps do have wet markets or are selling fresh meat [65, 66], further guidance needs to be developed specifically for camp settings to address the human risk of zoonotic disease transmission within wet markets and slaughtering practices in camps. Food safety guidance for camp-settings have been developed, but further research needs to be done on assessing the burden of zoonotic disease transmission from food sources in camp settings.

While LEGS, SPHERE, and UNHCR all have guidance documents that address livestock in refugee camps and that there can be an increased risk of zoonotic disease transmission in refugee camps due to varying factors, we have not yet come across any tools to help assess or measure the risk of zoonotic disease transmission in refugee camps. Once a tool is developed, it should be incorporated into already existing resources, like UNHCR's Needs Assessment for Refugee Emergencies Checklist, to further encompass One Health within complex emergencies.

Conclusions

Zoonotic diseases are a risk to vulnerable populations, like refugees and IDPs. Due to the lack of current guidance on how to assess, prevent, and mitigate zoonotic disease risk in camp-like settings, camp management should begin thinking about ways to further incorporate One Health approaches into complex emergencies. While this scoping review focused on displaced populations, populations surrounding camps are also at risk for zoonotic disease transmission. Displaced and refugee populations are migrant and through migration diseases can spread and be introduced to other populations, which in turn continues to put others at risk for zoonotic disease transmission. With the rising trend in displaced

populations, further efforts need to be made to reduce diseases, particularly emerging and re-emerging zoonoses, in camp settings and surrounding populations. Increased collaboration between organizations and agencies working within animal health, human health, and the environment will continue to help mitigate and control zoonotic disease within these vulnerable populations and settings.

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Figures

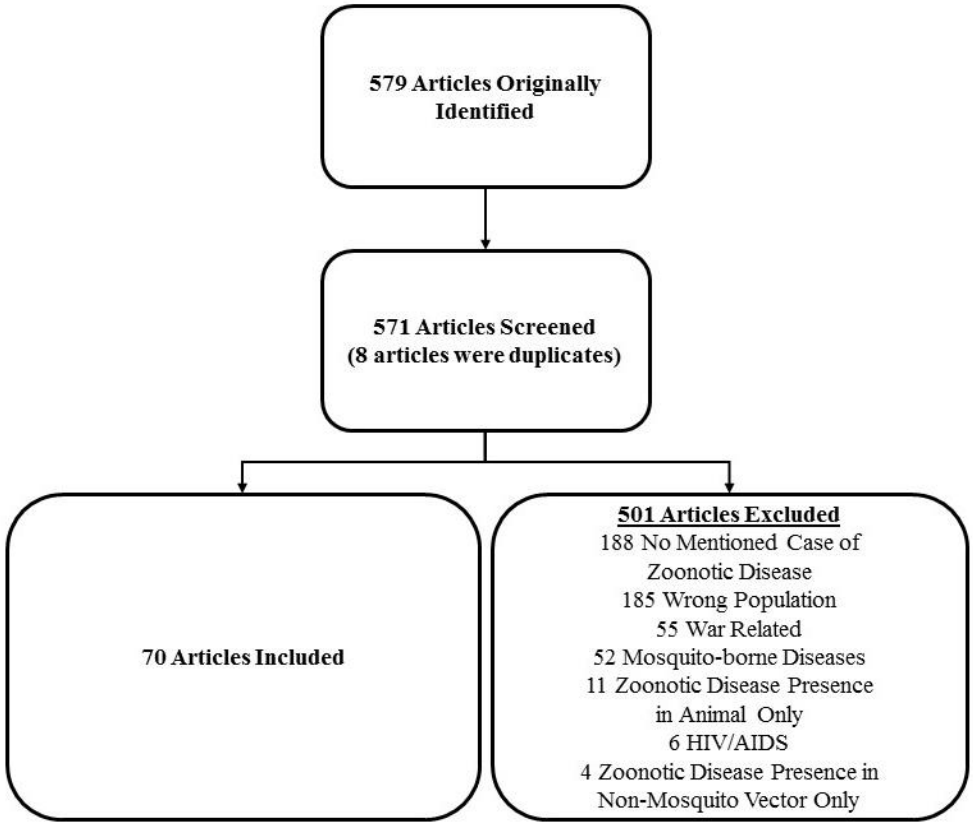

Figure 1. Schematic of articles included and excluded from the review

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

The raw data used and analyzed for this review are available on reasonable request. Please contact Grace Goryoka at grace.goryoka@gmail.com.

Competing Interests

The authors declare that they have no competing interests.

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Author's Contributions

GG was responsible for the protocol development, data collection and analysis, and manuscript development.

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Chapter 4. Recommendations and Conclusions

From this scoping review, cases or suspected cases of zoonotic diseases are present within refugees, IDPs, camps and conflict settings. Vulnerable populations are at an increased risk of contracting infectious diseases, including zoonotic diseases.

Existing Guidance Documents

While some guidance documents have been developed targeting animal husbandry, management, and health within camp settings, these documents should be do not address zoonotic diseases, specifically disease prevention, control, and risk assessments.

- The *UNHCR Livestock-Keeping and Animal Husbandry in Refugee and Returnee Situations* manual was developed in 2005 to provide managers and those working in specific refugee operations "the most appropriate forms of livestock keeping and management" [33]. This document can be updated to include and further discuss the risk of zoonotic disease from livestock-keeping and animal husbandry practices and address suggested actions camp managers can take to mitigate zoonotic disease risk in camps.
- Livestock Emergency Guidelines and Standards (LEGS) Project has developed a LEGS handbook which provides standards and guidelines "for appropriate and timely livestock-based livelihoods responses in emergencies, using a participatory and evidence-based approach" [12]. Further realistic recommendations on managing wildlife and domestic animals in camp settings can possibly be further integrated into the LEGS
- SPHERE handbook was developed to serve as international guidance for humanitarian assistance. SPHERE encompasses minimum standards that describe "conditions that must be achieved in any humanitarian response in order for disaster-affected populations to survive and recover in stable conditions and with dignity" [34]. SPHERE guidance does not directly address zoonotic disease risk, aside from vector control. Vector control guidance heavily focus on

mosquito control, but further guidance needs to be developed to focus on other vector sources (rodents, fleas, sandflies, and ticks). While SPHERE discusses that shelter of livestock should not be in the same shelter as where people are, further guidance needs to be developed in conjunction with other organizations whom develop guidance documents to incorporate animal management practices and biosecurity measures at household levels within camps in order to protect people. SPHERE guidelines should continue to address human health but begin to incorporate further information regarding the risk of zoonotic disease transmission for managing livestock, wild and domestic animals in camp settings.

- Médecins Sans Frontières (MSF), an independent medical organization, has also developed guidance documents for delivering medical aid to refugees, like their book, "Refugee Health An Approach to Emergency Situations" [142]. The MSF refugee health book is fairly comprehensive at addressing the needs of vector borne diseases beyond mosquitos, but should also further incorporate other potential zoonotic diseases.
- UNHCR's "Epidemic Preparedness and Response in Refugee Camp Settings" was developed to help camps establish outbreak preparedness and response capacities [131]. Much of this guidance document refers solely to zoonotic avian influenza. With the presence of zoonotic diseases in camps, this guidance should be expanded to include additional zoonotic diseases of concern.

Surveillance Systems

Within refugee camps the surveillance system that is utilized is Health Information Systems (HIS) which has been developed as a tool for camps to collect, compile, analyze and distribute health information about the health of refugees [143]. During an emergency, a country may choose to implement Early Warning Alert and Response Network (EWARN). EWARN's primary objective is to "rapidly detect and respond to signals that might indicate outbreaks and clusters of epidemic-prone diseases" [144]. While

EWARN guidance has incorporated some zoonotic diseases within its framework, further emphasis should be placed on the risk of zoonotic diseases in camps that can cause high morbidity and mortality. EWARN and HIS solely focus on human surveillance. Camp decision makers and public health professionals may want to further incorporate and integrate animal surveillance systems with human surveillance systems to be better prepared to respond to a potential zoonotic disease outbreak. Surveillance systems in camps may not be capturing zoonotic diseases when they are occurring in camps because they either may not be sensitive enough or health systems are not even looking for zoonotic disease. The evidence found regarding zoonotic disease within camps for this review was found from specific studies or articles and not from routine surveillance data, highlighting the gap in available surveillance data within this subject area. Additionally, surveillance for zoonotic disease can also be implemented into sentinel laboratory systems that have been established in some camps. Surveillance officers should work closely with veterinarians and animal surveillance officers to assess risks within camp settings and further incorporate animal surveillance into human surveillance. This comprehensive surveillance approach may provide public health professionals a more efficient and timely response. Additionally this incorporation of two different surveillance systems will further integrate the animal health and human health sectors. These opportunities for further collaboration can continue to enhance and engage the One Health approach in camp settings. UNHCR's "Epidemic Preparedness and Response in Refugee Camp Settings" begins to discuss incorporating and monitoring animal surveillance for avian influenza preparedness [131]. This recommendation should be broadened beyond avian influenza and additional guidance documents should be developed for camp managers to utilize.

Enhancing Collaboration

Given the evidence of zoonotic disease risk within camp settings and no current guidance on how to mitigate this risk, a One Health approach is needed within emergencies and camp settings. Inclusion of local municipality animal health officers, the ministry of agriculture, or non-governmental organizations

working within the animal health sector, like Veterinarians Without Borders, and the World Organisation for Animal Health (OIE), is needed to create risk assessments, guidance, and interventions to protect both animal, human and environmental health. Interventions like animal vaccination campaigns or the procurement of vaccinations can be carried out by animal health organizations. If animals are entering camps or affecting camp populations from outside of the camp setting and from the local community, work with the local municipality to take action for vaccination campaigns [71].

Further research and development

While LEGS, SPHERE, and UNHCR all have guidance documents that address livestock in refugee camps and that there can be an increased risk of zoonotic disease transmission in refugee camps due to varying factors, no known tools or assessments exist to help measure the risk of zoonotic disease transmission in refugee camps. LEGS does discuss the risk of zoonotic disease transmission and has developed assessment questions and frameworks for livestock in emergencies, but does not allow camp management to make informed decisions or provided recommendations on what should be done to mitigate risks in one place. A tool or assessment should be developed and can be incorporated into already existing resources, like UNHCR's Needs Assessment for Refugee Emergencies Checklist, to further encompass One Health within complex emergencies. The risk assessment tool should be used as a guidance tool to inform decision makers in camp settings of practical and informative interventions to mitigate the risk of zoonotic disease transmission in camps. The tool should be flexible and adaptable to each camp's needs and variations. Additionally a tool should be able to present decision makers with recommendations to help mitigate the risks their camp is facing.

Also, since some camps do have wet markets or are selling fresh meat [65, 66], further guidance needs to be developed specifically for camp settings to address the human risk of zoonotic disease transmission within wet markets and slaughtering practices in camps. Food safety guidance for camp-

settings have been developed, but further research needs to be done on assessing the burden of zoonotic disease transmission from food sources in camp settings.

Zoonotic diseases are a risk to vulnerable populations, like refugees and IDPs, and camp management should begin thinking about ways to further incorporate One Health into complex emergencies. This increased collaboration between organizations and agencies working within animal health, human health, and the environment will continue to help mitigate and control zoonotic disease within these vulnerable populations and settings. Due to a rising trend in CHEs, conflict, and population displacement, camp-like settings are growing worldwide and further attention needs to be placed within this field of communicable diseases to protect vulnerable populations from the risk of zoonotic disease transmission.

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