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Conflict And Vaccine-Preventable Disease In Children Under Five In The Eastern Mediterranean Region: A Systematic Review

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CONFLICT AND VACCINE-PREVENTABLE DISEASE IN CHILDREN UNDER FIVE IN THE EASTERN MEDITERRANEAN REGION: A SYSTEMATIC REVIEW

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Background: Conflict is one of the main reasons for our failure to reach worldwide immunization targets. An objective of 90% immunization coverage is included in the fourth Millennium Development Goal to reduce under-five mortality by two thirds, which is still far from achieved in the conflict-ridden Eastern Mediterranean Region (EMR). Despite global progress, vaccine-preventable deaths still account for 20% of childhood mortality under five years of age in the EMR, and communicable disease a third of all mortality. Conflict remains a critical root cause of low vaccination coverage in the EMR, resulting in high levels of vaccine-preventable disease, disability, and death.

Research Question: The aim of this review is to assess the impact of conflict on vaccine-preventable disease vaccination coverage and outcomes in children under five in the Eastern Mediterranean Region. While international attention is drawn to outbreaks of polio and measles, several other easily avoidable infections are also responsible for high rates of morbidity and mortality, especially in children. This review will give a more holistic view on the burden of vaccine-preventable disease associated with conflict, as well as identify gaps in our current knowledge and explore common factors in prevention of immunization uptake.

Methods: This systematic review was performed using the PRISMA guidelines. Search terms related to conflict, the EMR, vaccines in the WHO Expanded Programme for Immunization (EPI) package, and children were entered into MEDLINE, Embase, Global Health, and Cochrane. Eighty seven unique articles were identified, and after an abstract and full text review and a forward search, 26 were retained for data extraction and analysis.

Results: Results were distributed between four different countries of origin (Afghanistan, Pakistan, Somalia, and Sudan), five different countries of study (Afghanistan, Pakistan, Sudan, Somalia, and Kenya), and six out of ten diseases in the EPI (poliovirus, measles, hepatitis B, tetanus, diphtheria, and pertussis). The majority of results addressed poliovirus (n=16) and measles (n=9). Outcomes, vaccination coverage, and barriers to vaccination was analyzed according to disease.

Conclusions: There is a large gap of knowledge regarding vaccine-preventable diseases in children under five in conflict-affected areas of the Eastern Mediterranean Region. Understanding the prevalence, mortality, and barriers to vaccination involved in these challenging environments will help us reach the WHO goals of 90% vaccination coverage and reduce worldwide childhood mortality.

Introduction

Conflict and infectious disease come hand in hand, as we are recently reminded by outbreaks of polio, measles, typhoid, and hepatitis A in the growing Syrian refugee camps. Three years of civil conflict has led to the death of 125,000 and the displacement of over 2.7 million (UNHCR 2014). Polio has reemerged after 14 years of elimination due to the breakdown of health systems and lack of sanitation, and 80% of excess deaths can be attributed to communicable disease. Unfortunately, many these deaths were easily preventable – immunization coverage was as low as 60% across Syria in 2012, leaving the population increasingly vulnerable to outbreaks (Coutts & Fouad, 2014). This situation is not uncommon in the Eastern Mediterranean Region (EMR).

In the 20th century, between 191 and 231 million people died as a direct or indirect result of conflict, with civilian greatly outnumbering combatant deaths (Otterson et al., 2014). In 2013 alone, the UNHCR estimated 38.7 million people of concern throughout the world, including refugees and internally displaced people (UNHCR, 2013).

Table 1. Countries in the Eastern Mediterranean Region (EMR), as defined by the World Health Organization

Afghanistan	Kuwait	Saudi Arabia
Bahrain	Lebanon	Somalia
Dijbouti	Libya	Sudan
Egypt	Morocco	Syrian Arab Republic
Iran	Oman	Tunisia
Iraq	Pakistan	United Arab Emirates*
Jordan*	Qatar*	Yemen

**has not experienced a conflict since 1975 (Uppsala, 2013)*

The EMR is particularly conflict-ridden, beyond Syria's ongoing conflict (see Table 1). Since 1975, 18 out of 21 countries in the region have experienced some sort of organized conflict (Uppsala, 2013). Conflict-related mortality increasingly shifts towards the civilian population, and civilian death accounts for 90% of conflict-related mortality in the 21st century (Okonko et al., 2009). Specifically in the EMR, hundreds of thousands of civilian deaths are estimated in the last decade in Afghanistan, Iraq, and Syria alone, and 10.8 million refugees and IDPs have resulted from conflicts solely in Afghanistan, Pakistan, Sudan, and Syria (Otterson et al., 2014; UNHCR, 2013). Mortality is highest among children under five years of age largely due to the disruption of normal childhood health services, resulting in high rates of diarrheal diseases, acute respiratory infections, measles, malaria, and severe malnutrition, followed by outbreaks of other communicable diseases such as pertussis and meningococcal meningitis (Zwi, 2006; Toole & Waldman, 1997). A large portion of these deaths are easily preventable with vaccination. Causes of death have not changed significantly since the change of the century, emphasizing the necessity of increasing uptake of vaccination in conflict-affected areas (Moss et al., 2006).

The implications of conflict reach beyond violence-related death and disability to the destruction of infrastructure, food shortages, and the mass displacement of people, creating an ideal environment for the spread of infectious disease (Toole & Waldman, 1997). In recent conflicts in Iraq and Syria, healthcare services have been directly targeted, forcing physicians to flee and hospitals to be deserted (Otterson et al., 2014). These conflicts disrupt the delivery of essential interventions such as vaccinations, in addition to making populations more vulnerable to infectious diseases and interrupting surveillance and response programs (Okonko et al., 2009). Vaccination is a highly cost effective intervention, as available care post-infection is limited, with an estimated total of $162 per capita spent on healthcare in the EMR, compared to the global average of $845 in 2009, and even less in conflict-areas of the EMR (Haq et al., 2013). In these low-income settings, vaccination is an essential, cost-effective intervention needed to prevent excess mortality.

Conflict and vaccine-preventable disease

Conflict is known to be one of the main reasons for our failure to reach worldwide immunization targets (Haq et al., 2013). An objective of 90% immunization coverage is included in the fourth Millennium Development Goal, to reduce under-five mortality by two thirds, which is still far from achieved in the conflict-ridden EMR.

Vaccination efforts in the EMR began in 1974 with the founding of the Expanded Programme on Immunization (EPI) by the WHO. EPI was created to expand access to vaccination to children and women in developing countries, at a time when less than 5% of children worldwide were receiving vaccinations in the first year of life. At the time, the "traditional" package included four vaccinations (BCG, DPT, OPV, and measles) for six diseases: tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis, and measles (UNICEF, 2011). The EPI was progressively adopted by all countries, and was universal by the early 1980s (Mansoor, 2008).

By 2013, global coverage of these four vaccinations reached 83%, and the EPI vaccination package now includes eight vaccinations targeting a total of ten diseases (listed in Table 2) (UNICEF, 2011). Yellow fever vaccine was added to the package in 1988 for affected countries in Africa and South America; yellow fever is recommended for Sudan and Somalia, so it was included in this systematic review (Gershman & Staples, 2013). Hepatitis B vaccine was added in 1992 for high burden countries and expanded to all countries by 1997. *Haemophilus influenzae* type B (Hib) was added to the list for high burden countries in 1998 and extended to all countries by 2006. Possible vaccinations being considered as future additions to the EPI package may include pneumococcal conjugate vaccine (PCV), rotavirus vaccine, human papillomavirus vaccine (HPV), and regionally specific vaccines including typhoid, Japanese encephalitis, and meningitis (Mansoor, 2008).

The EPI has since developed the Global Vaccine Action Plan (GVAP), which aims to eliminate polio and prevent 24-26 million deaths through the expanded vaccination package by 2020 (WHO 2013, GVAP, 2013). One of the elements of GVAP's Strategy is to research the best delivery approaches for humanitarian emergencies, fragile states, and countries in or emerging from conflict (GVAP, 2013).

Despite this global progress, vaccine-preventable deaths still account for 20% of childhood mortality under five years of age in the EMR (WHO-EM, 2011), and communicable disease a third of all mortality in the region (Haq et al., 2013). Weak health systems, insufficient government financial allocations, low community awareness and trust of services, regional instability, and lack of coordination between humanitarian and health care workers hinders the effective delivery of health services such as vaccination (Haq et al., 2013; Okonko et al., 2009). Conflict remains a critical root cause of low vaccination coverage in the EMR, resulting in high levels of vaccine-preventable disease, disability, and death.

Table 2. Vaccine-preventable diseases included in the Expanded Programme for Immunization (EPI)

Diphtheria	Poliomyelitis
Hepatitis B	Rubella
Haemophilus Influenzae type B	Tetanus
Measles	Tuberculosis
Pertussis (whooping cough)	Yellow Fever

Prevention and response

Prevention of these vaccine-preventable diseases is difficult to navigate in conflict settings. Adequate food, shelter, water, sanitation and immunization are difficult to achieve in war-

affected countries. Early warning systems, surveillance, and emergency preparedness planning are critical to establish before situations become unmanageable, with a foundation of standard public health policies, treatment protocols, staff training, and the maintenance of reserves of essential drugs and vaccines for use in emergencies (Toole, 1997). Rapid assessments are often overlooked, when the early identification of the most vulnerable sub-populations could save many lives. Initially channeling resources towards addressing measles, diarrheal disease, malnutrition, and acute respiratory infections among women and children is know to be a cost effective approach to preventing excess mortality. Immunizing children between 6 months and 5 years of age is known to be the single most important and cost-effective intervention in emergency-affected populations, which should then be followed by the other vaccines in the EPI package (Haq et al., 2013).

The current guidelines for prevention of vaccine-preventable disease in the Sphere Project Minimum Standards in Humanitarian Response call for an immediate estimation of measles vaccination coverage in children aged 9 months to 15 years to prevent future outbreaks. If vaccination coverage is below 90%, a vaccination campaign should be launched for children aged 6 months to 15 years, including Vitamin A administration, and coverage should be maintained above 95% for any mobile or displaced populations as newcomers come to the camp. Measles vaccination should then be followed with the rest of the EPI package as soon as the situation has somewhat stabilized (Sphere Handbook, 2011).

Research questions

The aim of this systematic review is to assess the impact of conflict on vaccine-preventable disease outcomes in the Eastern Mediterranean Region. While international attention is drawn to outbreaks of polio and measles, a long list of other easily avoidable infections is responsible for high rates of morbidity and mortality, especially in children. This review will give a more holistic view on the burden of vaccine-preventable disease associated with conflict, as well as identify gaps in our current knowledge and explore common factors in prevention of immunization uptake. Until these factors are better understood and addressed, achievement of the MDGs will continue to fall short.

Methods

Literature was reviewed based on the preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines.

Search strategy for identification of studies

Searches were conducted in the databases MEDLINE, Embase, Global Health, and Cochrane Library, and all searches were limited to the English language and from 1974 (the year that EPI was established) to the February 2014 search date. Search criteria included a combination of one or more conflict-related terms, one or more vaccine-preventable disease-related terms, and all countries included in the WHO-defined Eastern Mediterranean Region. It should be noted that the EMR differs from the World Bank-defined Middle East and North Africa (MENA) Region by a few countries (EMR does not contain MENA countries Algeria, Israel, Malta or West Bank & Gaza, but does contain Afghanistan, Pakistan, Somalia, and Sudan) (WHO, 2014; World

Bank, 2013). Conflict-related keywords included "refugees," "internally displaced," "displaced persons," "conflict affected," "post conflict," "war," and "terrorism." Search terms for vaccine-preventable diseases included "diphtheria," "hepatitis B," "haemophilus influenza type B", "measles," "whooping cough," "poliomyelitis," "rubella," "tetanus," and "pertussis." Child-related terms included "child" and "infant." See appendix Table A1 for the full search strategy.

Search terms related to conflict were based on those used in systematic reviews by Jack et al. (2013) and Roberts & Browne (2010). Child-related search terms were based on those used in the systematic review about child mental health in conflict by Jordans et al (2009). Vaccine-preventable disease terms were taken from the included vaccines in the EPI package (Mansoor, 2008). Countries included in the search terms included all of those in the World Health Organization list of countries in the Eastern Mediterranean Region (WHO, 2014).

Study selection

When screening the search results, articles that did not address populations within the Eastern Mediterranean Region and one of the pre-specified vaccine-preventable diseases were omitted. In addition, editorials and commentaries were excluded. Studies addressing refugees who were relocated to high-income countries were excluded due to their differing circumstances compared to those still living in low- and middle-income countries. Beyond these initial criteria, articles were evaluated by comparing them to the main components of our study question:

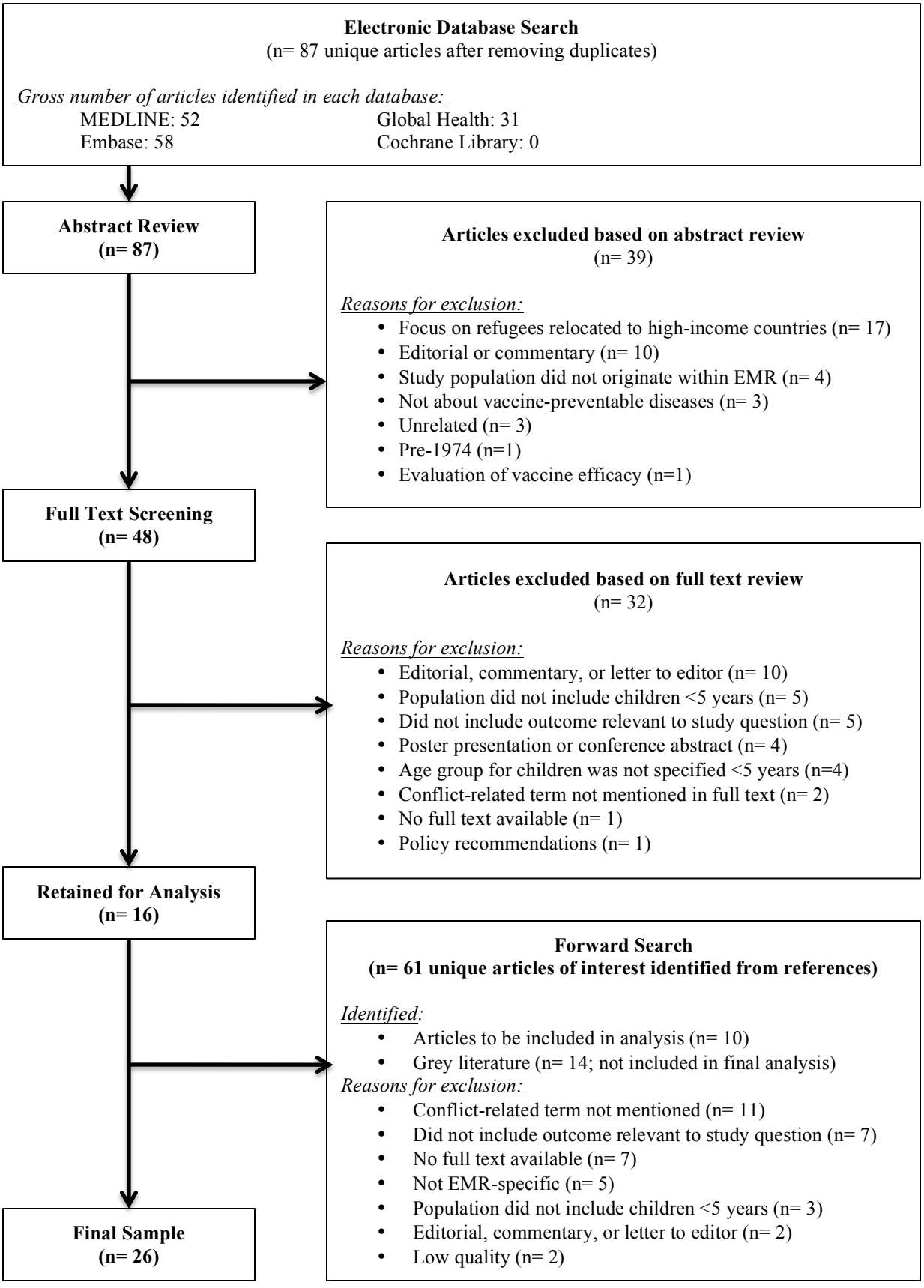
1. Is the article specifically focused on children under five in a conflict-affected population?
2. Is the article examining risk factors or outcomes of mortality, incidence, and/or prevalence of vaccine-preventable diseases?

The database searches yielded 87 unique results after removing duplicates (see Figure 1 for selection process). The abstracts of this initial sample were screened by a single reviewer, resulting in the exclusion of 39 articles. The most common reasons for exclusion included a focus on refugees relocated a high-income country (n= 17) or an editorial or commentary (n=10).

Forty-eight articles were retained for full text review. Articles were excluded if they were a commentary, editorial, or letter to the editor, did not include an outcome relevant to the study question, a conflict-related term did not appear in the full text, the population didn't include children under five, or the full text was not available.

At the conclusion of full text screening, a total of 16 articles were retained for data extraction and analysis. A forward search was performed on the references of these 16 articles, and 61 articles were identified to be of potential interest to the research question based off of their titles. After screening these 61 articles, 10 were added to the final sample, 14 were identified as grey literature, and 37 were excluded based on the criteria used in the full text screening. The grey literature was not included in final data extraction and analysis.

Figure 1.
Systematic Literature Review Process



Results

A total of 26 articles were retained in the final sample. Of these, 17 studies were Morbidity and Mortality Weekly Reports (MMWRs) or Weekly Epidemiological Records (WERs) from the CDC. Despite the inclusion criteria of studies published since 1974, publication years ranged only from 1987 to 2014, with an average year of 2005. A full list of results and some basic characteristics are included in the appendix in Table A2.

Types of Participants

Studies were included in the final sample if the participants were five years of age or younger and were living in or recently displaced from a country in the Eastern Mediterranean Region. Studies that defined children as <15 or <10, with no further breakdown to <5, were excluded. Participants originating within the EMR and relocated to a low or middle income country were included, but participants relocated to a high income country were excluded. Only one article (Polonsky, 2013) addressed populations that originated within the EMR and relocated outside to another low income country, Kenya. Studies were not included unless they mentioned conflict, but the Uppsala Conflict Database was also used to cross-verify that the countries of participant's origin and/or study were conflict affected.

Location

Studies took place in Afghanistan, Pakistan, Somalia, Sudan, and Kenya. The participants' countries of origin included Afghanistan, Pakistan, Somalia, and Sudan. Populations studied Kenya originated in Somalia. Several studies in Pakistan also studied populations originating in Afghanistan. The majority of articles focused on populations originating in either Afghanistan or Pakistan. See Table 2 to see the full list of countries of origin and countries of study for the articles included in the final sample.

Table 2. Results by Country of Origin and Study

	Origin	*Study*		*Origin*	*Study*		*Origin*	*Study*
Afghanistan	16	14	Kuwait	-	-	Saudi Arabia	-	-
Bahrain	-	-	Lebanon	-	-	Somalia	5	4
Dijbouti	-	-	Libya	-	-	Sudan	2	3
Egypt	-	-	Morocco	-	-	Syrian Arab Republic	-	-
Iran	-	-	Oman	-	-	Tunisia	-	-
Iraq	-	-	Pakistan	13	15	United Arab Emirates	-	-
Jordan	-	-	Qatar	-	-	Yemen	-	-
						Kenya*	-	1

**Note: Kenya is not in the EMR, but the population studied originated from Somalia, a country in the EMR, so it was included in this study.*

Vaccine-preventable diseases

Out of the 10 vaccine-preventable diseases included in the EPI and included in this systematic review, only 6 were addressed in the final sample of articles. The majority of studies focused on poliomyelitis or measles, while only a few results addressed hepatitis B, tetanus, diphtheria, and whooping cough. Four EPI-included diseases were not found in the results, including Haemophilus influenza type B, rubella, tuberculosis, and yellow fever. A full list of results by vaccine-preventable disease is contained in Table 3. See Table 4 for a matrix of results comparing vaccine-preventable disease to population's country of origin.

Table 3. Results by Vaccine-Preventable Disease

Diphtheria	1	Poliomyelitis	16
Hepatitis B	1	Rubella	-
Haemophilus Influenzae type B	-	Tetanus	2
Measles	9	Tuberculosis	-
Pertussis (whooping cough)	1	Yellow Fever	-

Table 4. Matrix of Results Comparing Country of Origin to Vaccine-Preventable Disease

	Diphtheria	Hepatitis B	Measles	Pertussis	Poliovirus	Tetanus
Afghanistan		1	3		12	1
Pakistan					13	
Somalia	1		5	1		1
Sudan			1		1	

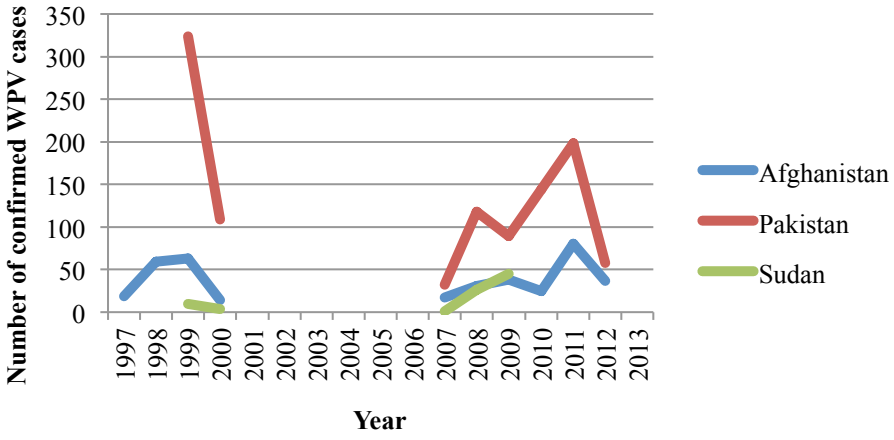
Poliomyelitis

Sixteen results addressed poliomyelitis in countries of the EMR. Of these 16 results, only one was not a CDC MMWR or WER report. In addition, while each of these results was unique, five pairs of reports presented the same annual data for cases and vaccination coverage for Afghanistan and Pakistan.

Only one result did not include Afghanistan and/or Pakistan, instead focusing on polio in Sudan (MMWR, 2001). One result also gave an EMR-wide update (MMWR, 2000). Several of the worldwide CDC updates did include numbers for other countries in the EMR (such as Egypt and Sudan) but focused primarily on Afghanistan and Pakistan (MMWR, 2008; MMWR, 2009; MMWR, 2010). Poliovirus remained endemic only in Afghanistan, Pakistan, and Nigeria by 2012, explaining the lack of results for other countries in the EMR. Poliovirus-specific results are documented in the appendix Table A3, with extraction of the number of cases and immunization coverage for each article in the final sample.

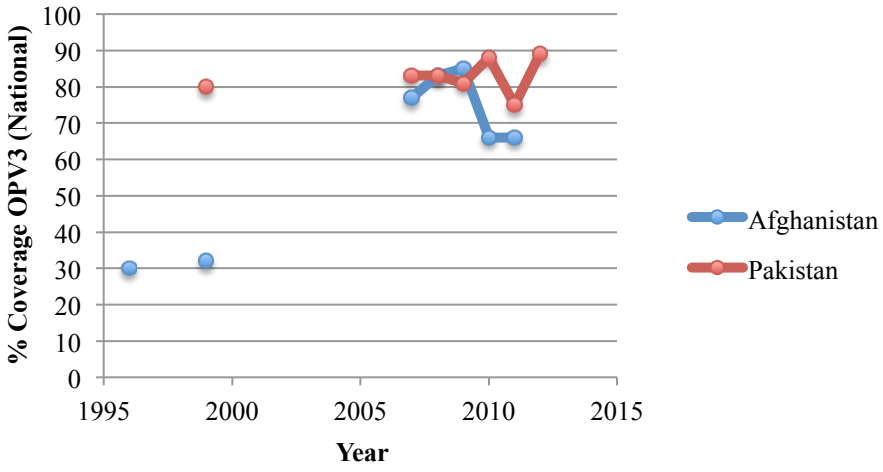
The number of confirmed WPV cases widely fluctuates in Afghanistan and Pakistan since the first result in 1997 (see Figure 2). Poliovirus is not considered endemic in Sudan, and transmission has been interrupted since 2009 (GPEI, 2010). No WPV3 cases have been reported in Afghanistan since April 2010, and WPV3 persists in small numbers in Pakistan (MMWR, 2013). WPV2 was eliminated in 1999. In 1999, six countries reported indigenous strains of poliovirus: Afghanistan, Egypt, Iraq, Pakistan, Sudan, and Somalia (CDC MMWR, 1999). In the most recent report, only Afghanistan and Pakistan still had reportable cases (CDC MMWR, 2013), although the recent Syrian refugee outbreak will likely increase incidence in other EMR countries as well.

Figure 2. Wild poliovirus cases in the EMR, as reported by CDC MMWRs



Vaccination coverage increased from the least to most recent articles included in both Afghanistan and Pakistan. Vaccination coverage was defined as three doses of oral polio vaccine (OPV) in children less than one year old. In Afghanistan, the earliest article reported less than 30% OPV coverage in 1996 (CDC WER, 1999), whereas the latest article reported coverage of 66% in 2011 (CDC MMWR, 2013). This coverage fluctuated, reaching as high as 85% coverage in 2009 (see Figure 3 for reported OPV coverage in Afghanistan and Pakistan) (CDC MMWR, 2010). Pakistan typically reported higher vaccination coverage than Afghanistan, but these data were not reliable until recently and were most likely gross overestimations, especially when considering the limited AFP surveillance data available (CDC MMWR, 2009). In addition, Sudan reported routine OPV coverage of 90%, with some regional variation (CDC MMWR, 2001).

Figure 3. Oral Poliovirus Vaccine Coverage (3 Doses) in Afghanistan and Pakistan, according to CDC MMWR Reports



Regional differences in coverage were large in both countries. Provinces along the insecure common border had the lowest immunization coverage throughout the years. In 2009, a range of 5 to >20% of children under five years in certain regions were inaccessible for vaccination due to

security issues in Afghanistan, and a range of 10 to 30% of children in Pakistan (CDC MMWR, 2010). In Afghanistan in 2010, 84% of cases came from the conflict-affected south region, and 69% of cases in Pakistan came from conflict-affected Federally Administered Tribal Areas (FATA) and Kyber-Pakhtoonkhwa Province (CDC MMWR, 2011). Every article in the poliovirus sample subgroup described wide regional variation within the affected countries, based on conflict and logistical access issues.

Supplementary immunization activities (SIAs) were common interventions used in Afghanistan, Pakistan, Sudan, as well as other non-endemic countries to reach high-risk endemic areas and migrant populations, trying to reach chronically missed children (CDC MMWR, 2012). National immunization days (NIDs) were also a common SIA referred to in every article, which were mass campaigns that occurred over a short period of time, administering two OPV doses to children under five years (CDC MMWR, 2001). SIAs totaled 26 in Pakistan and 18 in Afghanistan in 2008 (CDC MMWR, 2009), 23 in Pakistan and 13 in Afghanistan in 2009 (CDC MMWR, 2010), and 20 in Pakistan and 12 in Afghanistan in 2010 (CDC MMWR, 2010).

Commonly cited barriers to vaccination coverage included active conflict, insecurity and weak managerial and operational coordination (CDC MMWR, 2013; CDC WER, 1999; CDC MMWR, 2008; CDC MMWR, 2009; CDC MMWR, 2010; CDC MMWR, 2011). Increased resources and political commitment were repeatedly called for (CDC MMWR, 2009; CDC MMWR, 2011; CDC MMWR, 2012). Surveillance was weak or completely lacking for acute flaccid paralysis (AFP) cases. Attacks on polio workers in December 2012 and early 2013 also stalled SIA activities in Pakistan until increased security precautions were taken for workers. However, accompaniment of polio workers by law enforcement has not had a positive influence on increasing community vaccine acceptance or reducing parent refusal (CDC MMWR, 2013).

Measles

Nine articles addressed measles in the EMR, including five in Somalia, three in Afghanistan, and one in Sudan. Most of these articles studied measles mortality on a refugee camp level. Mortality for children under five years of age was disproportionately high in all of these camps, and every study noted that measles, along with acute respiratory infections and diarrhea, was one of the main causes of death. Percentage of death attributed to measles ranged from 8% in Afghan refugee camps in 1984 (Boss, 1987) to over 60% in refugee camps in Somalia in the early 1980s (Toole, 1988). Vaccination coverage also was reported as very low in every study, with the highest coverage at 83.9% in Somali refugee camps in Kenya in 2011 after a vaccination campaign following an outbreak (Polonsky, 2013), whereas countrywide vaccination coverage within Somalia was reported as only 46% in 2010 and 2011. This two year interruption in vaccination coverage resulted in a massive measles outbreak, with cases increasing from 145 to 1562 cases per million children under five years (Kebede, 2012). The need for persistent, high coverage of vaccination was also demonstrated in the study in Kenya, where the breakdown in registration and vaccination services resulted in a measles outbreak, spiking measles to account for 17% of under five mortality (Polonsky, 2013). In addition, several studies showed high resident mortalities from measles in addition to displaced and refugee populations (Moore, 1993; Gessner, 1993), demonstrating the negative effects of conflict and infectious disease not only on refugees and displaced people, but also residents of the countries.

Reasons for low coverage of measles vaccination included widespread fighting and insecurity, remote location of communities, stock-outs, rainy seasons, and mass population

movement (Boss, 1987; Toole, 1988; Assefa, 2001; CDC WER, 2004; Mirza, 2012). Many articles stated entire regions were inaccessible for vaccination due to conflict, such as the southern and central regions in Somalia in 2010 and 2011 (CDC MMWR, 2012) and western Darfur in Sudan in 2004 (CDC WER, 2004). A few articles recommended strengthening of community health programs to improve vaccination coverage, vitamin A delivery, and malnutrition (Moore, 1993; Assefa, 2001). Child Health Days in Somalia proved to be an effective approach, closing the gap between rural and urban populations and reaching 84% more infants than prior traditional EPI approaches (Mirza 2012). Outbreak response immunization (ORI) strategies were also implemented on a large scale in Kenya and Sudan. However, measles cases persisted after the ORI campaigns, emphasizing the need for thorough prevention over rapid response (CDC WER, 2004; Kebede, 2012). Several articles also called for improved surveillance in conflict settings in order to determine the most effective approaches and technologies for prevention and follow-up (Gessner, 1993; Toole, 1988; CDC WER, 2004).

Tetanus, Diphtheria, and Pertussis

Two articles addressed tetanus (Boss, et al., 1987; Mirza et al., 2012) and one additionally addressed diphtheria and pertussis (Mirza, et al., 2012). While improvements in child mortality were observed from 1984 to 1985 among Afghan refugees in Pakistan with a decrease from 22.5% to 18.8% of children dying before their fifth birthday, neonatal tetanus increased in percentage of cause of death from 6 to 9%. However, differences were not statistically significant. The EPI's goal by 1990 was less than one death from neonatal tetanus per 1000 live births, while this camp still had a level of 17 tetanus deaths per 1000 births (Boss et al., 2012).

The other study examined Somalia and its efforts with its child survival intervention of Child Health Days within an unstable country with poor infrastructure. Child Health Days were conducted every six months and were found to be successful in reducing urban and rural disparities as well as increasing third dose of DPT coverage from 31% in 2008, to 51% in 2009, to 66% in 2010. Security constraints in some regions proved to be the greatest obstacles to increased coverage, but CHDs overall provided increased coverage compared to the usual efforts of routine EPI services in Somalia's fragmented healthcare system (Mirza, et al., 2012).

Other vaccine-preventable diseases

Only one result was found for hepatitis B, concerning Afghan refugees in Pakistan (Quddus, 2006). Seroprevalence in children under five was 5.9% (95% CI: 2.4 – 11.9%; Quddus, 2006) compared to 2.4% prevalence in the general Pakistani pediatric population (Ali et al., 2009). In addition, HBsAg positive mothers were 7.15 times more likely to have HBsAg positive children. Hepatitis B vaccination was not included in the Balochistan camps at the time of the study, and the article highly recommended its inclusion as a routine immunization (Quddus, 2006).

No results were found studying Hib, rubella, tuberculosis, or yellow fever in children under five in conflict-affected EMR countries. Hib vaccine was only universally introduced into the EPI package by 2006, which may explain the lack of results, and yellow fever is only recommended in Somalia and Sudan (CDC, 2013). Tuberculosis typically affects older populations, explaining the lack of results for children under five years old.

Discussion

Countries and conflict timelines

Afghanistan has been in a constant state of conflict since 1978, involving intrastate conflict with foreign involvement. Severe civil war, the Taliban movement, and US-led international intervention characterized the constant state of upheaval and insecurity (Uppsala, 2013). This history heavily influences Afghanistan's weak health system and inability to eradicate polio. Also, extensive foreign involvement may explain the large number of results based in Afghanistan.

Pakistan has also experienced multiple interstate and intrastate conflicts since 1975. Pakistan has engaged in clashes with India, was involved in the War on Terror against al-Qaida, and has experienced many military coups and struggles over government power (Uppsala, 2013). Provincially localized conflicts have heavily influenced vaccination coverage and disease outbreaks, resulting in the high percentage of inaccessible populations reported in the CDC MMWRs.

Sudan also is characterized by constant conflict. Especially noteworthy was South Sudan's fight for independence, which was won in 2011, followed by continued struggles over the establishment of the border. The Sudan People's Liberation Movement/Army struggled with the government from 1983 to 2004, along with fighting in Darfur in 2003. Sudanese militias are infamous for human rights violations and large scale one-sided violence (Uppsala, 2013). Again, this persistent conflict through the decades explains historically low vaccination coverage, mass displacement of people, and outbreaks of disease.

Somalia's armed conflict has been continuous since the early 1980s, when opposition groups attempted to overthrow President Barre. After his ousting in 1991, international troops became involved until 1995 and Somalia went through two decades of dysfunctional governance while also suffering from drought and famine (Uppsala, 2013). Mass displacements of people, lack of governance, pervasive conflict, and a fragmented health system in which 80% of Somalis lacked basic care have precipitated the crisis of high mortality from vaccine-preventable disease (Mirza, 2012).

Strategies for moving forward

Strategic interventions are needed to reach these inaccessible children for vaccination and prevent excess mortality associated with conflict. As shown throughout this systematic review, prevention of these diseases becomes extremely difficult in insecure settings, despite the effectiveness and cost-benefit of vaccination. Prevention can happen on many levels: primary prevention equates to conflict resolution and stopping the violence; secondary prevention involves contingency planning, surveillance, and personnel training; tertiary prevention means the prevention of excess mortality through mass vaccination campaigns and humanitarian relief (Toole & Waldman, 1997). Some recommendations for each level of prevention surfaced throughout many of the articles in this review.

Interruption of poliovirus faces barriers posed by a disastrous mix of armed conflict, high population density, poor sanitation, low of vaccination coverage, and weak or absent health infrastructure (CDC MMWR, 2000). The Global Polio Eradication Initiative (GPEI) enacted a strategic plan in 2010 in order to stop transmission of wild poliovirus by 2012. This plan focuses

on targeted and planned approaches to address heterogeneity in OPV coverage and transmission (WHO GPEI, 2012). In 2011, GPEI stated that the world is not on track for its end of 2012 global goal of ending all WPV transmission, or for any time soon after, without tackling fundamental problems of security, managerial, and resource issues (CDC MMWR, 2012). Pakistan was identified as the greatest overall risk to the GPEI in its 2011 meeting (CDC MMWR, 2011).

Emergency plans were constructed for Afghanistan and Pakistan. SIAs need to involve local leaders in planning and social mobilization, in order to focus on hard-to-reach areas, tailor improved training, and target house-to-house canvassing. In addition, improved accountability is needed in administrative leaders to improve supervision, monitoring, and performance of vaccination teams (CDC MMWR, 2012). Technical support and human resources are needed in polio-endemic countries in order to develop national capacity and expertise (CDC MMWR, 2013). Better planning, coordination, and surveillance are critical to quash further polio transmission, and would operate on both the secondary and tertiary levels of prevention.

This mobilization of political commitment and resources could also help strengthen other immunization and preventive services, as demonstrated in other countries (CDC WER, 1999). Reaching high risk populations would help maintain a >95% measles vaccination coverage and ensure herd immunity, as well as disseminate other critical vaccines in the EPI package. Capacity for surveillance would grow, and awareness and utilization of routine services would increase. Better management and local stakeholder involvement would not only improve OPV implementation, but also build other basic health services.

"Days of tranquility" were also recommended in several of the articles of this search to help reach high risk areas in prolonged conflict and little central governance (CDC MMWR, 2012; CDC MMWR, 2010). In order to execute this cease-fire intervention, negotiations with community and conflict leaders needs to be enhanced. These days of tranquility will help reach districts in Afghanistan and Pakistan with persistent polio transmission, as well as vaccinate chronically missed children for measles in Sudan and Somalia. This strategy was used effectively in El Salvador, lasting through the conflict from 1985 to 1992 and allowing 300,000 children to be immunized annually, incidence of measles and tetanus to drop dramatically, and polio to be eliminated (Krug, et al., 2002).

Vaccine diplomacy is another strategy that hints at primary prevention. As defined by Novotny and Adams, global health diplomacy is "a political change activity that meets the dual goals of improving global health while maintaining and strengthening international relations abroad, particularly in conflict areas and resource-poor environments" (2007). Vaccine diplomacy offers a potential opening for not only scientific collaboration but also an avenue of foreign policy negotiations. The strategy dates back to the Cold War, in which US and Soviet doctors partnered to develop the oral polio vaccine and improve the smallpox vaccine, leading to eventual worldwide eradication. This model could be applied to diseases included in this systematic review or other neglected tropical diseases, fostering collaboration and cooperation while also serving the interests of both actors. Political, structural, and social peace building would be fostered as public- and private- sector leaders negotiate opportunities for public health interventions (Katz et al., 2011). Joint scientific collaboration with countries in the EMR could lead to better international health and improved global security, as well as serve the health of the society and the economy of these countries (Hotez, 2010).

More strategic interventions are needed to effectively increase basic vaccination coverage and reduce excessive mortality in children under five associated with conflict in the EMR.

However, as evidenced in this review, the key element must be total political commitment and collaboration.

Limitations

The nature of this systematic review introduced several elements of bias. Publication bias must be acknowledged, as many countries with fewer academic institutions or less foreign involvement would have fewer papers published. Only four out of 18 conflict-affected countries in the EMR had articles that fit the study criteria, and those four each have significant humanitarian and foreign involvement. In addition, publication dates averaged to 2005, despite a wide inclusion window from 1974 to present. This was partially influenced by increasing publication rates in more recent years, as well as recent pushes to increase vaccination coverage by GVAP, UNICEF, GPEI, the MDGs, and others. The international pressure for polio eradication may explain its high proportion of articles (n= 17). In addition, universal coverage of some of the EPI vaccines was only reached recently, perhaps explaining the lack of results for Hib, tuberculosis, rubella, and yellow fever.

The results also cannot be considered perfectly reliable. Many numbers used in the MMWRs are state reported, and other data are collected in challenging, insecure environments. Many cases are missed due to the retrospective nature of the household surveys, based on recall bias and dependent on the presence of at least one adult per household, and cause of death is often misclassified due to the inexact nature of the interviews and assignment of symptoms. While these studies are often the only way to estimate the current situation, they do not offer a perfect assessment.

An important limitation to note is the restriction of this systematic review to published literature. Grey literature of interest was identified in the forward search but not included in analysis, only for relevant information in background and discussion. In addition, only articles in English were included in this review, potentially missing many articles published from within the EMR.

Finally, only a single reviewer screened the abstracts and full texts. In the future, a second reviewer is needed to help reduce selection bias of articles and ensure that criteria are as rigorously adhered to as possible.

Future directions

This systematic review clearly demonstrates a large gap in the literature concerning EPI vaccination coverage and need in the EMR. Many conflict-affected countries are not represented in this sample. Further research must be done to understand the impact of vaccine-preventable diseases in conflict-affected areas and the interventions that would be most effective in each context.

Beyond the EMR, this exercise would also be useful in conflict-affected countries around the world. Vaccination delivery mechanisms across different countries and contexts would also be interesting to examine. Cross-regional learning could help countries roll out vaccination interventions in times of insecurity more effectively.

Conclusions

Conflict remains one of the greatest threats to public health, resulting in mass displacement of people, destruction of health infrastructure, and mass mortality by many easily preventable causes. In the Eastern Mediterranean Region, greater political commitment, surveillance, and operational capacity for national vaccination with the EPI package could result in a large number of lives saved in a cost-effective manner. Strategic approaches are needed to reach high risk populations and achieve polio eradication in these conflict-affected areas, as well as to prevent excess morbidity and mortality.

One of the most important results from this review is its emphasis on the need for improved documentation and evaluation of vaccination campaigns and vaccine preventable disease in conflict-affected areas. More efforts are needed to document the impact of these diseases in conflict areas, as well as evaluate effective intervention strategies, cost-effectiveness, and cost-benefits of different vaccines. As the EPI considers adding even more vaccinations to its basic package, it is important to understand the burden and necessity of their need in these emergency situations.

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Appendix

Table A1. Search terms included in initial database search

Conflict-related terms	EMR terms	EPI Vaccine-related terms	Child-related terms
Refugees refugee*.tw (internal* adj1 displace*).tw (displace* adj1 person*).tw (conflict* adj1 affected).tw (post* adj1 conflict*).tw War (wars or warfare or wartime or terrorism).tw	Afghanistan Bahrain Dijbouti Egypt Iran Iraq Jordan Kuwait Lebanon Libya Morocco Oman Pakistan Qatar Saudi Arabia Somalia Sudan Syria Tunisia United Arab Emirates Yemen	Poliomyelitis Diphtheria Tuberculosis Whooping cough Measles Rubella Tetanus Haemophilus influenzae type b Hepatitis B BCG vaccine Yellow fever (polio* or pertussis or HepB or HiB or DTP or OPV).tw	Child Infant Child*.tw
Limited to English language. *Limited to 1974 - present (EPI was established in 1974).*			

Note: Terms separated by "OR" within columns; terms separated by "AND" between columns.

Table A3. Description of Final Results

Author (Year)	Title	Country of Population's Origin	Country where study took place	Disease studied	Relevant findings
Original articles from database search					
Assefa (2001)	Malnutrition and mortality in Kohistan district, Afghanistan, April 2001	Afghanistan	Afghanistan	Measles	In the midst of a long civil conflict, the crude mortality rate of children under 5 years was 5.6 per 10,000 per day, with 15.7% of deaths attributed to measles. Polio vaccine coverage was low at 73.7%.
Boss (1987)	Infant mortality and childhood nutritional status among Afghan refugees in Pakistan.	Afghanistan	Pakistan	Measles, Tetanus	From 1984 to 1985, the percentages of deaths <5 increased from 6 to 10% due to tetanus and 8 to 24% due to measles. However, overall percentage of death <5 improved from 22.5 to 18.8%.
Gessner (1994)	Mortality rates, causes of death, and health status among displaced and resident populations of Kabul, Afghanistan	Afghanistan	Afghanistan	Measles	Highest mortality rates occurred in those <5 years who had been at their current location <10 months. Measles as cause of death in both displaced and residents <5 years were respectively 18% and 10%.
MMWR (2001)	Progress toward poliomyelitis and dracunculiasis eradication - Sudan, 1999-2000	Sudan	Sudan	Poliovirus	AFP surveillance improved and the number of children <5 vaccinated increased due to NIDs and door-to-door campaigns. However, southern Sudan still has low OPV coverage of estimated 20%.
MMWR (2009)	Progress towards interruption of wild poliovirus transmission - Afghanistan and Pakistan, 2008	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Despite coordinated SIAs, polio incidence and the percentage of children <5 years living in inaccessible areas increased from 2007 to 2008 in both countries. Security access remained the top barrier to vaccination access.
MMWR (2009)	Progress towards interruption of wild poliovirus transmission - worldwide, 2008	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Afghanistan and Pakistan reported 31 and 118 WPV cases, respectively, attributing most cases to conflict-affected regions and border areas with security problems. OPV3 coverage was 83% and 44 SIAs occurred in both countries combined.
MMWR (2010)	Progress towards interruption of wild poliovirus transmission - worldwide, 2009	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Afghanistan and Pakistan reported 38 and 89 WPV cases, respectively, with difficulties continuing with accessing children in insecure areas.
MMWR (2011)	Progress Toward Poliomyelitis Eradication — Afghanistan and Pakistan, January 2010-September 2011	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	WPV incidence increased in both Afghanistan and Pakistan during 2010-2011, with cases occurring mainly in conflict-affected, inaccessible regions that are insecure for vaccination teams.
Kebede (2012)	Measles - Horn of Africa, 2010-2011	Somalia	Somalia	Measles	Interruption of MCV services for 2 years due to conflict led to a massive measles outbreak, increasing from 145 to 1562 cases per million children <5 years. Refugees also transported measles to

					neighboring Ethiopia and Kenya.
MMWR (2012)	Progress Toward Poliomyelitis Eradication — Afghanistan and Pakistan, January 2011-August 2012	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	WPV incidence fell from 2011 to 2012, but remains endemic in inaccessible areas of both countries due to insecurity, where hundreds of thousands of children are still unvaccinated.
MMWR (2013)	Progress towards poliomyelitis eradication in Pakistan, January 2012 - September 2013	Pakistan	Pakistan	Poliovirus	The number of WPV cases decreased from 54 to 52 from the same period a year prior. OPV3 coverage was 89% with a large range between provinces, due to security limitations, vaccination bans, and targeted attacks against polio workers.
Naeem (2012)	Coverage and causes of non immunization in National Immunization Days for polio; a consumer and provider perspective study in Peshawar.	Pakistan	Pakistan	Poliovirus	NIDs have been a partial success, with significant discrepancies between rural and urban and other sociodemographic factors. EPI staff also faces difficulties such as transport, lack of awareness, and security.
Polonsky (2013)	High levels of mortality, malnutrition, and measles, among recently-displaced Somali refugees in Dagahaley camp, Dadaab refugee camp complex, Kenya, 2011	Somalia	Kenya	Measles	Due to breakdown in registration and vaccination approaches, a measles outbreak resulted in 17% of deaths, with an overall <5 death rate of 1.8 per 10,000 person-days in the camp.
Quddus (2006)	Prevalence of hepatitis B among Afghan refugees living in Balochistan, Pakistan	Afghanistan	Pakistan	Hepatitis B	Refugee mothers who were HBsAg positive were much more likely to have an HBV infected child (OR = 7.15). Children <5 had a high prevalence of 5.9%.
WER (1999)	Progress toward poliomyelitis eradication, Afghanistan 1994-1999	Afghanistan	Afghanistan	Poliovirus	Coverage of OPVs in children <5 was estimated at 30% or lower for many regions, with most vaccination occurring during NIDs. Polio remained the leading cause of disability in Afghanistan.
WER (2004)	Prevention of measles deaths in Darfur, Sudan	Sudan	Sudan	Measles	Measles outbreaks ensued after conflict broke out with 711 cases and >10% case fatality rate. Mass vaccination campaigns had limited success; coverage was most restricted in high conflict Western Darfur and cases continued to occur.
Articles from Forward Search					
Mirza (2012)	Somalia: Supporting the Child Survival Agenda When Routine Health Service is Broken	Somalia	Somalia	Diphtheria, tetanus, pertussis, measles	Child Health Days have effectively immunized 84% more infants with measles vaccination than routine EPI services and narrowed the gap between rural and urban coverage.

MMWR (2000)	Progress toward poliomyelitis eradication - Eastern Mediterranean Region, 1999 - September 2000	Afghanistan, Pakistan, Sudan	Afghanistan, Pakistan, Sudan	Poliovirus	Compared with the same1999 period, confirmed cases in the EMR decreased by 50%. Pakistan accounts for 60% of cases. Transmission interruption is expected in all but 4 countries by the end of the year.
MMWR (2008)	Progress toward poliomyelitis eradication - Afghanistan and Pakistan, 2007	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Reduced to its lowest levels, WPV is still endemic to Afghanistan and Pakistan due to insecurity on the borders. OPV3 coverage was 83% in Pakistan and 77% in Afghanistan with large regional variance.
MMWR (2008)	Progress toward interruption of wild poliovirus transmission - worldwide, January 2007 - April 2008	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	WPV1 cases decreased substantially in Afghanistan but not in Pakistan despite little change in WPV3 cases; transmission continues due to security and managerial issues on the border.
MMWR (2010)	Progress toward poliomyelitis eradication - Afghanistan and Pakistan, 2009	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Coordinated SIAs continued, but were limited by security issues and population displacement. Up to 20% of children were inaccessible in both countries at certain times of the year.
MMWR (2011)	Progress toward interruption of wild poliovirus transmission - worldwide, January 2010 - March 2011	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Afghanistan reported decreases in WPV cases from 2009 to 2010, but Pakistan reported significant increases despite conducting many SIAs. Increased political commitment and resources are needed.
MMWR (2012)	Progress toward interruption of wild poliovirus transmission - worldwide, January 2011 - March 2012	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	Despite large reductions in worldwide WPV incidence, substantial increases were reported in WPV cases for Afghanistan from 2010 to 2011, along with marginal increases in Pakistan.
MMWR (2013)	Progress toward eradication of polio - worldwide, January 2011- March 2013	Afghanistan, Pakistan	Afghanistan, Pakistan	Poliovirus	WPV cases decreased in both Afghanistan and Pakistan with OPV3 coverage of 66% and 75% respectively, with substantial in country variability. However, attacks on health workers threaten progress.
Moore (1993)	Mortality rates in displaced and resident populations of central Somalia during 1992 famine	Somalia	Somalia	Measles	In displaced persons camps, <5 mortality was estimated at 74% with primary causes of death as diarrhea and measles.
Toole (1988)	An analysis of mortality trends among refugee populations in Somalia, Sudan, and Thailand	Somalia	Somalia, Sudan	Measles	Mortality rates for children <5 in Somali and Sudanese refugee camps were extremely high, up to 5 times higher than non-refugee children in these countries. Up to 60% of <5 deaths in some camps were due to measles.

Table A4. Data Extraction from Final Results by Vaccine-Preventable Disease

Main EMR Country of Origin	Main Country of Study	Year	Reported # of Cases	Total Observations	Overall <5 Mortality	Disease-specific % of death	Vaccination Coverage of Population	Author (Pub Year)	Type of Study	Level of Population

POLIOVIRUS

Afghanistan	Afghanistan	1994-1999	19 in Sept-Dec 1997; 59 in 1998; 43 in Jan-Aug 1999	N/A	N/A	N/A	<30% (3 doses) in 1996; ~80% (2 doses) in 1997	WER (1999)	Progress update	Countrywide
Afghanistan, Pakistan, Sudan	Afghanistan, Pakistan, Sudan	1999 - Sept 2000	63 in Afghanistan; 324 in Pakistan; 10 in Sudan in 1999	N/A	N/A	N/A	32% in Afghanistan; 80% in Pakistan, 77% in Sudan	MMWR (2000)	Progress update	EMR-wide
Sudan	Sudan	1999-2000	10 in 1999; 4 in 2000	N/A	N/A	N/A	90% in 1999; 70% in 2000 (3 doses to <5 years)	MMWR (2001)	Progress update	Countrywide
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2007 - Apr 2008	17 in 2007 and 5 in Jan-Apr 2008 in Afghanistan; 32 in 2007 and 4 in Jan-Apr 2008 in Pakistan	N/A	N/A	N/A	77% in Afghanistan; 83% in Pakistan (3 doses in <1 years)	MMWR (2008)	Progress update	Worldwide
Afghanistan, Pakistan	Afghanistan, Pakistan	2007	17 in Afghanistan; 32 in Pakistan	N/A	N/A	N/A	77% in Afghanistan; 83% in Pakistan (3 doses in <1 years)	MMWR (2008)	Progress update	Countrywide
Afghanistan, Pakistan	Afghanistan, Pakistan	2008	31 in Afghanistan; 118 in Pakistan	N/A	N/A	N/A	83% in both (3 doses in <1 years)	MMWR (2009)	Progress update	Countrywide
Afghanistan, Pakistan	Afghanistan, Pakistan	2008	31 in Afghanistan; 118 in Pakistan	N/A	N/A	N/A	83% in both (3 doses in <1 years)	MMWR (2009)	Progress update	Worldwide
Afghanistan, Pakistan	Afghanistan, Pakistan	2009	38 in Afghanistan; 89 in Pakistan	N/A	N/A	N/A	84% in EMR (3 doses in <1 years)	MMWR (2010)	Progress update	Worldwide
Afghanistan, Pakistan	Afghanistan, Pakistan	2009	38 in Afghanistan; 89 in Pakistan	N/A	N/A	N/A	85% in Afghanistan; 81% in Pakistan (3 doses in <1 years)	MMWR (2010)	Progress update	Countrywide
Pakistan	Pakistan	2010	N/A	600 households with children <5	N/A	N/A	83.7% (3 doses)	Naeem (2012)	Cross-sectional household survey	Province level
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2010 - Mar 2011	25 in 2010 and 1 in Jan-Mar 2011 in Afghanistan; 144 in 2010 and 26 in Jan-Mar 2011 in Pakistan	N/A	N/A	N/A	86% in EMR (3 doses in <1 years)	MMWR (2011)	Progress update	Worldwide
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2010 - Sept 2011	25 in 2010 and 42 in Jan-Sept 2011 in Afghanistan; 144 in 2010	N/A	N/A	N/A	66% in Afghanistan; 88% in Pakistan (3 doses in <1 years)	MMWR (2011)	Progress update	Countrywide

			and 120 in Jan-Sept 2011 in Pakistan							
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2011 - Mar 2012	80 in 2011 and 6 in Jan-Mar 2012 in Afghanistan; 198 in 2011 and 15 in Jan-Mar 2012 in Pakistan	N/A	N/A	N/A	N/A	MMWR (2012)	Progress update	Worldwide
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2011 - Aug 2012	80 in 2011 and 17 in Jan-Aug 2012 in Afghanistan; 198 in 2011 and 30 in Jan-Aug 2012 in Pakistan	N/A	N/A	N/A	66% in Afghanistan; 75% in Pakistan (3 doses in <1 years)	MMWR (2012)	Progress update	Countrywide
Pakistan	Pakistan	Jan 2012 - Sept 2013	58 in 2012; 52 in Jan-Sept 2013	N/A	N/A	N/A	89% (3 doses in <1 years)	MMWR (2013)	Progress update	Countrywide
Afghanistan, Pakistan	Afghanistan, Pakistan	Jan 2011 - Mar 2013	37 in 2012 in Afghanistan; 58 in 2012 in Pakistan	N/A	N/A	N/A	66% in Afghanistan; 75% in Pakistan (3 doses in <1 years)	MMWR (2013)	Progress update	Worldwide

MEASLES

Afghanistan	Pakistan	1984-1985	10 in 1984; 27 in 1985	1512 households in 1984; 1566 households in 1985	225 per 1000 in 1984; 188 per 1000 in 1985	8% of deaths in 1984; 24% in 1985	N/A	Boss (1987)	Systematic household survey	Refugee camps
Somalia	Somalia, Sudan	1980-1985	N/A	3 camps in Somalia; 3 camps in Sudan	28 per 10,000 per day in Somalia; 22.2-32.6 per 10,000 per day in Sudan	60% in Somalia; most common cause in Sudan	78% in Somalia	Toole (1988)	Cluster household survey	Refugee camps
Somalia	Somalia	1992	33 in Baidoa; 39 in Afgoi	62 children in Baidoa; 211 in Bagoi	32 per 10,000 per day in Baidoa; 10.4 per 10,000 per day in Afgoi	25% in Baidoa, 34% in Afgoi	N/A	Moore (1993)	Cluster household survey	Refugee camps, residents

Afghanistan	Afghanistan	1993	9 displaced cases; 10 resident cases	312 displaced families; 300 resident families	1.9 per 10,000 person-day displaced; 1.1 per 10,000 person-day resident	18% in displaced; 10% in resident	74% of displaced; 78% of resident	Gessner (1993)	Cross-sectional household survey	City level
Afghanistan	Afghanistan	2001	14 deaths	763 children	5.9 per 10,000	23.70%	N/A	Assefa (2001)	Cluster household survey	District level
Sudan	Sudan	March-June 2004	711 cases	N/A	N/A	10% Case fatality rate	77%	WER (2004)	Outbreak investigation	Refugee camps
Somalia	Somalia	2009-2010	N/A	909,690 in 2009; 1,241,590 in 2010	180 per 1000 live births	N/A	84% of regions with >50% routine measles coverage	Mirza (2012)	Intervention evaluation	Countrywide
Somalia	Somalia	2010-2011	976 in 2010; 11,601 in 2011	N/A	N/A	N/A	46% in 2010 & 2011	Kebede (2012)	Progress update	Countrywide
Somalia	Kenya	2011	619 cases	6488 children <5 years	1.8 per 10,000 person-days	17%	83.90%	Polonsky (2013)	Systematic household survey	Refugee camp

HEPATITIS B

Afghanistan	Pakistan	2003	7	119	N/A	N/A	1%	Quddus (2006)	Cross-sectional household survey	Refugee camps

TETANUS *(Vaccination is DPT: Diphtheria, Pertussis, Tetanus)*

Afghanistan	Pakistan	1984-1985	8 in 1984; 11 in 1985	1512 households in 1984; 1566 households in 1985	225 per 1000 in 1984; 188 per 1000 in 1985	22% of neonatal deaths in 1984; 38% in 1985	N/A	Boss (1987)	Systematic household survey	Refugee camps
Somalia	Somalia	2009-2010	N/A	36,460 in 2009; 53567 in 2010	180 per 1000 live births	N/A	51% in 2009; 66% in 2010	Mirza (2012)	Intervention evaluation	Countrywide