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The recent outbreaks and reemergence of poliovirus in war and conflict-affected areas

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SUMMARY

Background: Poliomyelitis is a highly infectious disease caused by poliovirus, which becomes difficult to manage/eradicate in politically unstable areas. The objectives of this study were to determine the movement and management of such polio outbreaks in endemic countries and countries with reoccurring cases of polio and to determine the effect of political instability on polio eradication.

Methods: In this study, the extent of polio outbreaks was examined and modeled using statistical methodologies and mapped with GIS software. Data on polio cases and immunization were collected for countries with polio cases for the period 2011 to 2014. Weekly data from the Global Polio Eradication Initiative were collected for selected countries. The recent virus origin and current movement was mapped using GIS. Correlations between immunization rates, the Global Peace Index (GPI), and other indicators of a country's political stability with polio outbreaks were determined. Data were analyzed using SAS 9.4 and ArcGIS 10.

Results: For several reasons, Pakistan remains highly vulnerable to new incidences of polio (306 cases in 2014). Overall immunization rates showed a steady decline over time in selected countries. Countries with polio cases were shown to have high rates of infant mortality, and their GPI ranked between 2.0 and 3.3; displaced populations, level of violent crime rating, and political instability also were ranked high for several countries.

Conclusion: Polio was shown to be high in areas with increased conflict and instability. Displaced populations living in hard-to-reach areas may lack access to proper vaccination and health care. Wars and conflict have also resulted in the reemergence of polio in otherwise polio-free countries.

1. Introduction

Polio is a highly infectious disease caused by poliovirus, a virus that mainly infects young children. It invades the nervous system and may cause total paralysis.[1,2] Polio reached epidemic proportions in the early 1900s in countries with relatively high standards of living. Polio was brought under control after the introduction of effective vaccines in the 1950s and 1960s. It was not until the 1970s that polio was recognized as a major problem in developing countries and routine immunization was introduced.[3,4] In 1988, when the Global Polio Eradication Initiative began, polio was paralyzing more than 1000 children every day worldwide. As a result, more than 2.5 billion children were immunized against polio. Following this, the widespread use of oral polio vaccine (OPV) reduced the number of children paralyzed by polio from an estimated 350 000 in 1988 to just 1606 in 2009.[4]

Polio continues to circulate in several countries, with occasional spread to neighboring countries. Endemic countries include Afghanistan and Pakistan, the only two countries in 2015 never to have stopped polio transmission and global incidence.[4] In 2014, Pakistan was one of the three countries in the world (the others being Nigeria and Afghanistan) where polio remained an endemic viral infection. Although the polio immunization campaign in the country started in 1974, efforts towards eradication officially started only in 1993. About 60 rounds of vaccination were performed in the country up until 2007, but the infection is still endemic.[4,5]

On the African continent, early estimates of incidence were hampered by significant under-reporting. The decrease in reported cases has been accompanied by a reduction in the geographic

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extent of endemic areas, such that by 2006 only four countries had yet to stop poliovirus transmission worldwide, and in Africa only Nigeria was endemic for polio in 2014. Transmission has been persistent in these countries, and the onward spread to previously polio-free areas has presented a significant challenge to the Global Polio Eradication Initiative.[6]

In 2013, polio started to emerge in areas that had been polio-free for decades. The first suspected polio cases in Syria were identified in October 2013.[4] Shortly afterwards, it was announced that wild poliovirus (WPV) had been isolated from 10 paralyzed children in Deir Ez Zor, one of the most fiercely contested areas of the country. By late November, 35 children had been paralyzed by polio in three separate governorates of the Syrian Arab Republic, which had previously not recorded polio for over a decade.[7] In addition, World Health Organization (WHO) officials stated that the first Iraqi polio case was confirmed in March 2014 by the Ministry of Health of Iraq and had the same genetic fingerprint as the virus that paralyzed 27 children in eastern Syria in October. Both originated in Pakistan, one of the few countries in the world where polio has not been completely eradicated.[8]

Civil unrest and war contribute to the spread of infectious disease. Troops and equipment, as well as displaced persons, are constantly moving from one place to another during wars, carrying with them infectious disease organisms and vectors. This is combined with the destruction of the physical and often economic infrastructure of the area. Wars spur widespread mass migrations. Migrants are stressed, often emotionally and physically, so they may have low immunity to diseases endemic in the new area; in addition, they may bring with them diseases that are common in their former home but which are not endemic in the new area. This combination of conditions, especially in crowded makeshift refugee camps, may lead to disease epidemics.[6,7]

Civil unrest and wars have a great impact on the spread of infectious diseases. The objectives of this study were (1) to determine the extent of polio spread and vaccination coverage in endemic countries, neighboring countries, and other countries where polio is reemerging; (2) to determine the correlation of polio outbreaks/spread with wars and civil unrest, using the variables vaccination coverage, infant mortality rate, Global Peace Index (GPI), percent of population displacement, level of violent crime, and level of political instability in the selected countries; and (3) to map the outbreaks of polio and visualize their movement across the selected regions.

2. Methods

Weekly data on WPV cases were collected to determine the association between polio outbreaks and civil unrest and wars in endemic countries (Pakistan, Afghanistan, and Nigeria) and countries with a reemergence of polio cases (Syria and Iraq). The years 2011 through 2014 were selected based on the availability of data for the selected variables for Afghanistan, Cameroon, Equatorial Guinea, Ethiopia, Iraq, Kenya, Nigeria, Pakistan, Somalia, and Syria, from the Global Polio Eradication Initiative (available at http://www.polioeradication.org/Dataandmonitoring/Poliothisweek.aspx). In addition, data on polio immunization coverage among 1-year-olds in the selected countries for the period 2011–2013 (2014 data were not available) were collected from the WHO Health Service Coverage (available at http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=2443).

To determine the correlation of polio outbreaks in the endemic countries with wars and conflict, several variables were considered in the analysis, including the following: vaccination coverage, infant mortality rate (as a measure of population health and quality of living), GPI (a measure of the relative position of a nation and region in terms of peacefulness), population movement from endemic regions resulting from wars, level of violent crime, level of political instability, and the risk of outbreaks of poliomyelitis. The infant mortality rate – the number of infant deaths before age 1 year – is often used as an indicator to measure the health and wellbeing of a nation, because factors affecting the health of entire populations can also impact the mortality rate of infants (http://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm).

The infant mortality rate – the number of infants dying before reaching 1 year of age per 1000 live-births in a given year – was obtained from the World DataBank. Estimates were developed by the UN Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UN DESA Population; data available at http://data.worldbank.org/indicator/SP.DYN.IMRT.IN/countries?display=default).

The GPI, developed by the Institute for Economics and Peace (available at http://economicsandpeace.org/),[9] was used as another indicator of a country's political stability and to assess the social, political, and economic factors that influence its level of peace. In addition to the GPI, the percentage of displaced population, level of violent crime (rated with a score of 1–5), and level of political instability (rated with a score of 1–5) were also collected for the selected countries.

The data were analyzed using SAS 9.4.[10] Analysis of variance was used to determine the significance of differences in polio rates between the countries. Regression analysis was performed to determine the correlation between the polio rate and explanatory variables including immunization rate, infant mortality, GPI, percent of population displacement in the country, level of violent crime rating, and level of political instability rating. Geographical information system maps (GIS) were created using ArcGIS 10.0 to visualize the distribution of polio outbreaks in the endemic countries for the years 2013 and 2014.[11]

3. Results

A significant difference ($p < 0.001$) in polio cases during the study period was found among the countries of Afghanistan, Cameroon, Equatorial Guinea, Ethiopia, Iraq, Kenya, Nigeria, Pakistan, Somalia, and Syria (Figure 1). The highest rates of polio cases were observed in Pakistan, with an average of 164 cases per year for the four study years; the highest number of cases occurred in 2014 ($n = 306$), a 62% increase since 2001 (Figure 2). However, no significant change in polio cases over time was observed for the selected countries ($p > 0.05$).

Immunization rates showed a decline over time; however this was not significant ($p > 0.05$). The rates were significantly different ($p < 0.001$) among the countries. Immunization rates in Cameroon and Kenya were the highest (84%), and these countries correspondingly had the lowest numbers of polio cases. Somalia and Equatorial Guinea, on the other hand, had the lowest rates of polio immunization (47.6% and 33%, respectively). Somalia was one of the countries with the highest rates of polio during the study period. In Syria, immunization rates dropped 30% from 2011 (75% in 2011 to 52% in 2013). Polio reemerged in Syria after decades of polio-free status, with 35 cases in 2013. Immunization rates remained constant in Pakistan; however, the polio rates showed a significant increase, pointing towards other contributing factors for the spread of the disease.

To determine the association of polio reemergence in countries due to conflict and war, several variables were examined, including the infant death rate in each selected country as a measure of the country's health and wellbeing, the GPI as an attempt to measure the relative position of the nation and region in terms of peacefulness, the percentage of displaced populations within the country, level of violent crime rating, and political instability