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Polio immunity and the impact of mass immunization campaigns in the Democratic Republic of the Congo

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ABSTRACT

Background: In order to prevent outbreaks from wild and vaccine-derived poliovirus, maintenance of population immunity in non-endemic countries is critical.
Methods: We estimated population seroprevalence using dried blood spots collected from 4893 children 6–59 months olds in the 2013–2014 Demographic and Health Survey in the Democratic Republic of the Congo (DRC).
Results: Population immunity was 81%, 90%, and 70% for poliovirus types 1, 2, and 3, respectively. Among 6–59-month-old children, 78% reported at least one dose of polio in routine immunization, while only 15% had three doses documented on vaccination cards. All children in the study had been eligible for at least two trivalent oral polio vaccine campaigns at the time of enrollment; additional immunization campaigns seroconverted 5.0%, 14%, and 5.5% of non-immune children per-campaign for types 1, 2, and 3, respectively, averaged over relevant campaigns for each serotype.
Conclusions: Overall polio immunity was high at the time of the study, though pockets of low immunity cannot be ruled out. The DRC still relies on supplementary immunization campaigns, and this report stresses the importance of the quality and coverage of those campaigns over their quantity, as well as the importance of routine immunization.

1. Introduction

Poliomyelitis (polio) is an infectious disease caused by the poliovirus. Like other enteroviruses, poliovirus is transmitted primarily by the fecal-oral route. Poliomyelitis can affect individuals of any age, but primarily involves children aged less than five years. In < 1% of those infected, the virus invades the central nervous system and can cause muscle weakness and acute flaccid paralysis (AFP), usually in the lower limbs, though occasionally progressing to breathing difficulty, and even death [1]. At the time of writing, wild poliovirus (WPV) type 1 continues to circulate in Nigeria, Pakistan, and Afghanistan. WPV type 2 was last seen in 1999, while WPV type 3 was last seen in 2012 [2].

Poliomyelitis is preventable using injectable inactivated polio vaccines (IPV) and live attenuated oral polio vaccines (OPVs) [1,3]. For the Global Polio Eradication Initiative (GPEI), whose mission is complete eradication and containment of all wild and vaccine-related polioviruses, OPV is the vaccine of choice due to its low cost, ease of delivery, and improved ability to prevent person-to-person transmission [1]. Prior its global withdrawal in April 2016, trivalent OPV (tOPV) was the most commonly used vaccine, providing protection against all three serotypes of poliovirus [1]. Bivalent and monovalent formulations were also used in response to prevalent strains of circulating poliovirus. In April 2016, type 2 containing tOPV was removed from use globally in order to prevent rare adverse events associated with its use, including vaccine-associated paralytic poliomyelitis, and emergence of circulating vaccine-derived poliovirus type 2 (cVDPV2) [4].

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In the DRC, the Expanded Program on Immunization (EPI) was introduced in 1978, with the childhood vaccination schedule for polio including four doses of tOPV at birth, 6, 10 and 14 weeks of age. The DRC's Polio Eradication Program led by the country's EPI started in 1996, providing additional doses of OPV through house-to-house supplemental immunization activities (SIAs) in areas of the country with a high burden of disease. Until 2001, DRC was endemic for WPV transmission, and was considered a reservoir and exporter of virus to other countries. From 2001 to 2005, no WPV cases were reported in the DRC, and the interruption of WPV transmission was assumed. However, between 2006 and 2011, outbreaks of WPV1 and WPV3 were reported in 10 of 11 provinces as a result of numerous importations from Angola (Fig. 1). In addition, over 10 independent emergences of cVDPV2 were documented during 2004–2012 [5]. The last confirmed WPV case reported in Maniema province with an onset of 20 December 2011. More recently, two cVDPV2 outbreaks were declared in 2016, originating in Maniema and Haut Lomami (formerly Katanga) provinces.

Given the historical importation of poliovirus into DRC and frequent VDPV emergences, achieving and maintaining high population immunity is critical to the success of the GPEI. While immunization campaign coverage monitoring provides operational oversight of individual activities, it gives limited information about their cumulative effect. Vaccination history, when collected, may be highly biased due to imperfect and variable recording and recall [6,7]. Additionally, even if vaccination history could be obtained, estimates of protective efficacy from polio vaccination vary widely, for instance, between 30 and 100% for 3 doses of tOPV [8]. Lastly, secondary spread of vaccine viruses to contacts of vaccine recipients contributes to population immunity, but varies with population characteristics and is therefore difficult to account for in the absence of immunological data [9]. Therefore, in order to measure the effectiveness of polio immunization activities and identify populations with sub-optimal immunity, serologic assessment of the population is critical.

Nationally representative serologic studies of polio immunity have not been conducted in the DRC, or in the African region more broadly. There have been some targeted assessments of polio immunity, including recent studies in northern Nigeria, India, western China, and Pakistan [10–14]. In addition, there was a large-scale polio serosurvey in the United States from 2009 to 2010 [15], and a 2013 nutrition survey in Afghanistan which included polio serology [16]. In the DRC, Alleman et al. studied seroprevalence among adult women prior to an outbreak of WPV1 in 2010 and 2011, using samples obtained from ante-natal clinics in the DRC [17]. The authors identified relatively low immunity to type 1 poliovirus among adult women in Kinshasa and Bandundu where the outbreak affected adults, and relatively high immunity in Kasai-Oriental, where the WPV1 cases were exclusively children.

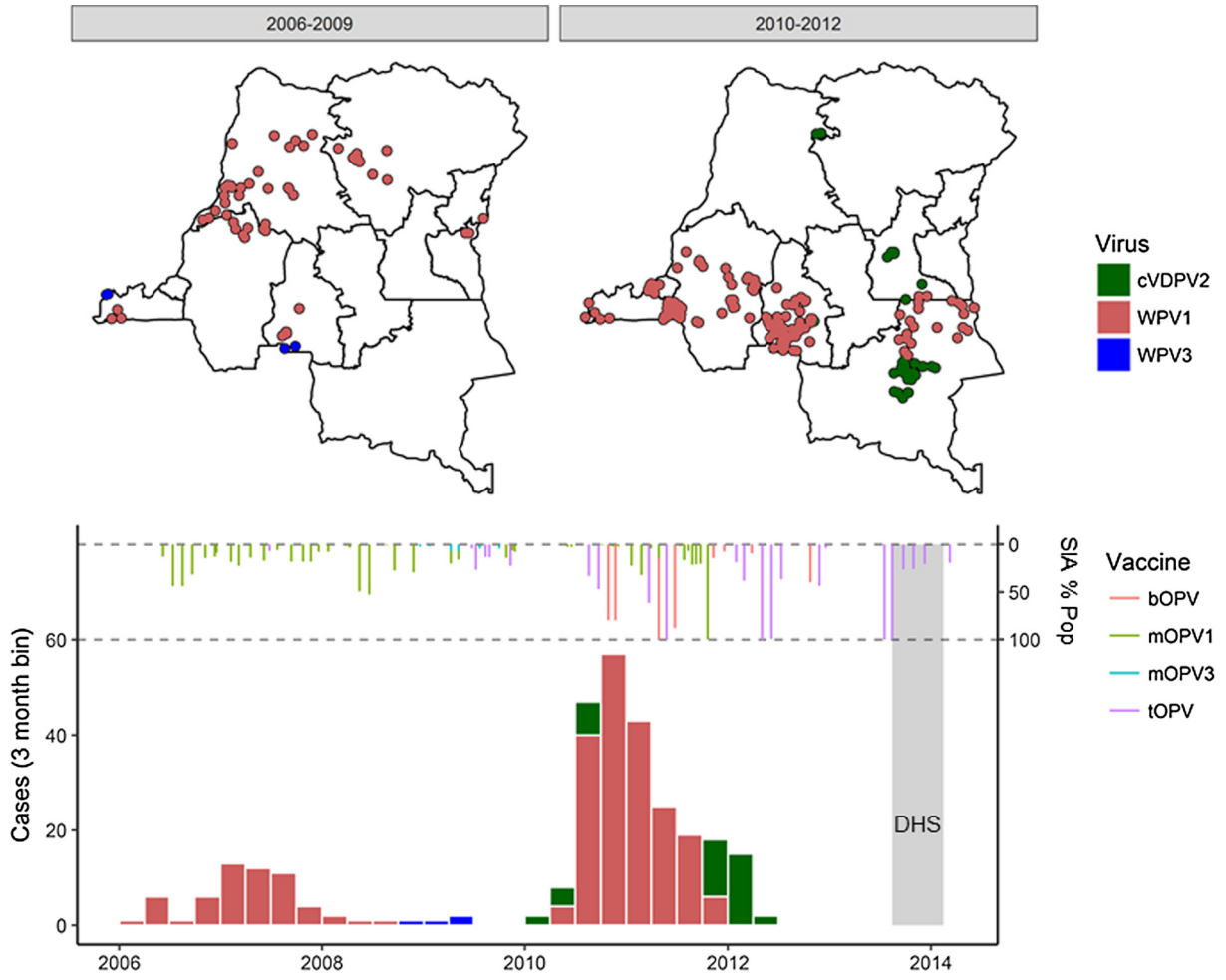

Fig. 1. Epidemiology and polio vaccination program history in the DRC. Top panel: the geographic distribution of cases in the periods 2006–2009 and 2010–2012; points are placed randomly in the district where a child was present two weeks prior to the onset of paralysis. Bottom panel: polio AFP case count by three-month bins; above the case counts are bars representing supplemental immunization activities. The grey band shows the period in which the DHS survey was conducted.