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Short Communication

Co-administration of paediatric vaccines in Shanghai, China

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Introduction

The World Health Organization (WHO) recommends countries to include 11 antigens on a publicly-funded, paediatric Expanded Program on Immunization (EPI): Bacillus Calmette-Guérin, hepatitis B, polio, diphtheria-tetanus-pertussis (DTP), *Haemophilus influenzae* type b (Hib), pneumococcus, rotavirus, measles, and rubella.[1] Some of these diseases are still a significant source of morbidity and mortality in China, for example, there are 19,000 deaths from Hib disease each year.[2] China's EPI includes all of these vaccines, except for the Hib vaccine, the pneumococcal conjugate vaccine (PCV), and rotavirus, and the process to add vaccines onto the EPI is opaque.[3] Unlike vaccines provided for free through China's EPI, the Hib vaccine and rotavirus vaccine are currently available for purchase at immunization clinics, and a 7-valent PCV (PCV7) was available from 2008 to 2015, when the manufacturer declined to renew the import license. Uptake of EPI vaccines such as DTP is high, >95%, but uptake of non-EPI vaccines is very low and varies by demographic group.[4,5] For example, coverage of Hib vaccine and PCV7 is low among non-locals or the so-called 'floating population', those individuals or families who have moved into cities from rural regions sometimes only temporarily and generally for economic reasons.[4] Although non-locals can receive EPI vaccines for free just like locals, they have limited access to health insurance in cities and are often blamed for the spread of infectious diseases in cities.[6] When multiple shots are given during the same office visit, vaccination coverage and timeliness can be improved without compromising vaccine safety and efficacy.[7] In contrast to most Western countries, where a child typically receives a dose from multiple vaccines requiring several injections during the same office visit (i.e. co-administration), Chinese immunization clinics will generally only administer one or two vaccine doses to a child per office visit.[3] Moreover, PCV7 had not been authorized by the Chinese Food and Drug Administration to be co-administered, despite PCV co-administration representing standard practice elsewhere. Consequently, as more vaccines become available, the Chinese paediatric immunization schedule has become more complex.[3]

We examined co-administration of dose 1 from five different vaccine series: DTP; oral polio vaccine (OPV); Hib vaccine; PCV7; and rotavirus vaccine. These vaccines (along

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with a dose of hepatitis B vaccine) would typically be administered at a 2-month well child visit in the USA. The aim of this study was to compare co-administration of these vaccines by residency (non-locals and locals) and urbanicity (suburban and urban).

The Shanghai Centers for Disease Control collects vaccination records from all immunization clinics in 14 of 17 districts in the city (the other three districts had separate immunization information systems at the time of data collection). A stratified, random sample was drawn by selecting at least 5000 children from each birth year from 2005 to 2011 through randomizing children's records by their parent's telephone number.[4] Residency was a field in the database and refers to locals or non-locals. The 14 districts were categorized as urban or suburban based on standard definitions.[4] For each of the five vaccines considered, co-administration was defined as having the same date of administration as any vaccine in the DTP series, Hib vaccine series, PCV7 series, rotavirus series, measles- or rubella-containing vaccine series, or varicella vaccine series. Co-administration could also be with OPV dose 1, but no vaccination record was available for other doses in the OPV series. Children without any record of administration of a given vaccine were excluded from the analysis for that vaccine.

A multivariable log-binomial model, with co-administration as the outcome, output estimates of the incidence ratio, along with standard errors which were used to calculate 95% confidence intervals. This model included residency, urbanicity and birth year. The data were analysed in SAS version 9.3 (SAS Institute, Cary, NC, USA).

Incidence of co-administration

Of the 35,437 children, 53.5% were male, 59.7% were non-locals, and 68.9% lived in suburban areas. The children ranged in age from 7 months to 7 years of age. Most children had one dose of DTP (98.0%) and OPV (96.5%), but fewer had a dose of Hib vaccine (47.4%), PCV7 (10.1%), or rotavirus vaccine (19.7%). Co-administration was 10.3% for DTP dose 1, 12.4% for OPV dose 1, 19.2% for Hib vaccine dose 1, 3.4% for PCV7 dose 1, and 14.8% for rotavirus vaccine dose 1.

Table 1 shows the results of multivariable log-binomial regression models. Across birth years, there was an increasing trend in co-administration for every vaccine except OPV dose 1. Co-administration of DTP dose 1 was 4.37 times higher for non-locals than locals (95% confidence interval: 3.97, 4.81), and there was a significant relationship between co-administration and residency status for OPV and PCV7 dose 1.

Program implications

China has had notable success in immunizing children with EPI vaccines and reducing the incidence of diseases that are targeted in the EPI.[4,8] Encouraging early administration of vaccines, through their administration during the same office visit as other vaccines, would be an important step towards continued reduction of the occurrence of these diseases.

Table 1 – Co-administration of the first dose of five different vaccine series with other vaccines in different demographic groups, from multivariable log-binomial regression models of 35,437 children in Shanghai, China.

	DTP 10.3% co-administration		OPV 12.4% co-administration		Hib vaccine 19.2% co-administration		PCV7 3.4% co-administration		Rotavirus vaccine 14.8% co-administration	
	IR (95% CI)	P	IR (95% CI)	P	IR (95% CI)	P	IR (95% CI)	P	IR (95% CI)	P
Birth year (continuous)	1.04 (1.03, 1.06)	<0.0001	1.00 (0.98, 1.01)	0.6033	1.31 (1.29, 1.34)	<0.0001	1.29 (1.17, 1.42)	<0.0001	1.45 (1.39, 1.51)	<0.0001
Non-local vs local	4.37 (3.97, 4.81)	<0.0001	2.05 (1.91, 2.19)	<0.0001	1.07 (1.00, 1.14)	0.0507	1.83 (1.28, 2.62)	0.0010	1.08 (0.96, 1.22)	0.2093
Suburban vs urban	1.01 (0.94, 1.08)	0.8449	0.97 (0.91, 1.03)	0.3160	0.81 (0.76, 0.86)	<0.0001	0.69 (0.48, 0.98)	0.0300	0.88 (0.78, 0.99)	0.0364

Notes: CI, confidence interval; DTP, diphtheria-tetanus-pertussis vaccine; Hib, *Haemophilus influenzae* type b; IR, incidence ratio; OPV, oral polio vaccine; PCV7, 7-valent pneumococcal conjugate vaccine.