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Seroprevalence of pertussis among adults in China where whole cell vaccines have been used for 50 years

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Summary *Objective:* To estimate the true incidence of pertussis in Chinese adults who are at a childbearing age.
Methods: A total of 897 serum samples from healthy individuals aged 20–39 years were selected randomly from a large number of serum samples collected in 2010 in Beijing, China. Anti-pertussis toxin (Ptx) IgG antibodies were determined with the Virion/Serion ELISA kits using purified Ptx as a coating antigen.
Results: Only 124 (13.8%) were found to have undetectable anti-Ptx IgG antibodies. The mean concentration was 13.76 IU/ml (95% CI, 12.37–15.15). Forty-six (5.1%) subjects had anti-Ptx IgG levels greater than or equal to 40 IU/ml, indicative of a pertussis infection, and nine (1%) had IgG antibodies greater than or equal to 100 IU/ml, indicative of a recent infection within a year. No significant differences were observed between age groups of 20–29 and 30–39 years, or between genders.
Conclusions: Our study showed that about 5% of adults aged 20–39 years had positive anti-Ptx IgG antibodies, suggesting that adult pertussis is common in China. Giving a booster

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vaccination to pregnant women should possibly be considered in order to protect young infants who are too young to be vaccinated in this country.

Introduction

Pertussis, or whooping cough, is a highly contagious bacterial disease of the respiratory tract, caused by *Bordetella pertussis*. The disease occurs in all age groups, especially among infants in whom severe pertussis and deaths are not uncommon. Since the 1950s, large-scale vaccinations against pertussis have been implemented and have markedly reduced the morbidity and mortality of this disease all over the world. However, pertussis has seen a resurgence during the past few decades, even in countries with high vaccination coverage.[1] In 2012, The Pan American Health Organization/World Health Organization (PAHO/WHO) estimated that there have been 50 million cases of pertussis which have caused 300,000 deaths worldwide.[2] The disease is most dangerous in infants, with severe symptoms and complications. The incidence rate, hospitalizations and deaths are particularly high in the first two years of age (case fatality rate: 0.2% and 4% in developed and developing countries, respectively).[3] Infants who haven't completed their primary vaccinations account for the major burden of the disease and increased mortality. Furthermore, in many industrial countries including the United States, New Zealand, Australia and some European countries, a shift in the epidemiologic profile of pertussis to adolescent and adult populations has been found, and has attracted global concern.[4–6] Some proposed reasons contributing to the changes include: increased clinician awareness and reporting, an easier and a sensitive diagnosis by PCR, and possible changes in circulating *B. pertussis* strains.[1] Besides these, another possible reason is the weakened protection associated with the introduction of acellular pertussis vaccines.[7–9] It is known that adults and adolescents are the most notable source of transmission of the disease to infants.[10–12] Therefore, pertussis is still one of the leading causes of vaccine-preventable deaths throughout the world.

In China, vaccination against pertussis was introduced in the early 1960s. From 2007 onwards, both the diphtheria and tetanus toxoids and whole-cell pertussis vaccine (DTwP) and the diphtheria-tetanus-acellular pertussis vaccine (DTaP) are in use, but no data is available on how often each is used. Since 1982 infants are primarily administered with three doses of DTwP vaccines at 3rd, 4th and 5th months of life, and a booster dose is given at 18—24 months. The vaccination coverage of the primary three doses has been increasing, being greater than 99% since 2009 (Fig. 1). The number of notified cases has been decreasing, and a total of 2183 and 1712 cases were reported in 2012 and 2013 (Fig. 1).[13] However, local outbreaks of pertussis were reported in some regions of this country.[14,15] As demonstrated by enhanced scrutiny for pertussis-like symptoms from 2010 to 2012 in Tianjin, a neighboring city to Beijing, the annual incidence rate was found to be 23.52 cases/100,000 inhabitants. The incidence was at least 16 times higher than that obtained via hospital reports during the same period.[15] Several seroepidemiological studies conducted in other provinces of China also indicated that the incidence of pertussis is most likely underestimated.[2,16–18] However, the number of study subjects included in each age group was not sizable in these studies. In a recent prospective study conducted from 2012 through 2013 in Xi'an, China, more than half of the 313 children who had been coughing for more than two weeks were proven to be positive for *B. pertussis* when their nasopharyngeal swabs were tested by culture and PCRs. The result clearly showed that pertussis is common in young Chinese children who have been coughing for longer than two weeks.[19]

Beijing is the capital of the People's Republic of China, with 21 million permanent residents. Chaoyang District is the largest area of Beijing, having about one fifth of the population of Beijing. The vaccination program used in Beijing is the same as the above-mentioned national program. According to the Beijing Public Health Information Center in 2013, coverage of the three primary doses for the whole city is 99.87%, while the Chaoyang District is at 99.52%.[20] In Beijing, the number of reported pertussis cases has been less than 15 per year, with the incidence rate less than 0.1/100,000 inhabitants from 2004 to 2013.[21] However, whether the real incidence rate in this area has been underestimated is still unclear.

Since pertussis in infants is mostly transmitted by their family members,[12,22] we wanted to study specific serum anti-pertussis toxin (anti-Ptx) IgG antibodies in healthy adults aged from 20 to 39 years, and estimate the incidence of pertussis in the Chinese adult population. This information is needed in order to protect young infants against severe pertussis and improve the vaccination policy in China.

Methods

Study population and specimen collection

A large epidemiological investigation of HBV was performed in the Chaoyang District, Beijing, by the center for disease control and prevention (CDC) between May and December, 2010. There are 24 streets and 19 regions in this district, and each of them consists of more than 10 communities. Altogether, 12 streets and 10 regions were randomly selected, and for each street/region two communities were chosen randomly. In each community the residents were also randomly selected. Nearly 14,500 serum samples were collected from individuals aged from 0 to 82 years who were residents in this district. No pertussis outbreaks were reported in Beijing during the study period. Basic demographic and epidemiological data collected on each subject was recorded in detail, such as age, gender, address, date of sampling, medical histories with chronic diseases (such as cardiovascular and cerebrovascular diseases, diabetes, chronic renal diseases, cancer and other medical conditions), as well as HBV vaccination history and

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