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Seroprevalence of *Bordetella Pertussis* Antibody in Pregnant Women in Iran

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ABSTRACT

Background: The increasing incidence of pertussis among adolescents and adults in recent years is an alarming factor in transmission of the infection to non-immune infants and children. Vaccination of pregnant women, immediately after delivery and before being discharged from the hospital may help to protect mothers and their newborns against the disease. Decision making process, regarding maternal immunization, requires credible information and knowledge about seroepidemiology of the infection in pregnant women. The aim of this study was to determine the seroprevalence of *Bordetella pertussis* antibody among admitted pregnant women in Hamadan, western Iran.

Methods: In this cross-sectional study, 288 pregnant women admitted to the Fatemiyeh Hospital, Hamadan, western Iran, were enrolled into the study. After obtaining consent from every patient, serum samples were taken from patients and were kept frozen until testing. Serum level of *B. pertussis* antibody was measured using ELISA. Level of antibody higher than 24 U/ml was considered positive. The obtained data were analyzed using the statistical software SPSS.

Results: From 288 pregnant women, 126 (43.8%) were in their second trimester. Serological results in 103 patients (35.8%) were positive. The mean age of mothers with positive serology was 27.5±6 years old. Thirty-five percent of patients had a valid immunization record, and 1.57% of those with no vaccination record had a positive serology.

Conclusions: The level of immunity against *B. pertussis* in pregnant women was low. Immunization before or during pregnancy can stimulate newborn's immune response and gives them required protection against pertussis infection.

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Introduction

Pertussis can occur at all ages, but the peak incidence of the disease and its complications are higher among infants, less than a year-old who have not received all three doses of the vaccine against pertussis[1,2]. Worldwide, 20-40 million cases of pertussis are reported each year. Whooping cough is blamed for 200 to 400 thousand death incidents in infants per annum. The mortality rate of infants in developing countries is higher than 4% [3]. Contrary to the belief that there is lifelong immunity against the disease after the vaccination; lifelong immunity against *B. pertussis* is not provided either by the vaccine or the disease itself [4]. The amount of antibodies declines four years after receiving the last dose of the vaccine and after ten years will reach 0-20%[5]. The duration of immunity after whole-cell pertussis vaccination is short-lived, with little protection remaining after 10–12 years. After a three-dose infant primary series of a cellular pertussis vaccine, protection persists for at least 5-6 years; the duration of immunity after a four- or five-dose schedule is not yet known, but serologic and modeling studies suggest that a booster may be needed after 10 years [4]. The immunity acquired from the infection itself lasts about 10-15 years. Recently decline in overall immunity and an increased incidence of the disease, particularly among adolescents and adults considered a major factor and an important source for the transmission of the disease to infants and young children[4]. Therefore, preventive measures in controlling and monitoring *B. pertussis* infection among adults can play an essential role on protecting infants and young children who have not yet completed their vaccination against pertussis[1,5].

Infants under a year-old, particularly those younger than six months who have not yet received the vaccine for full protection against pertussis are depended on antibodies that are received from their mothers. Nonetheless, low levels of maternal antibodies and a rapid decline in neonatal levels of antibodies make infants prone to pertussis. Center for Disease Control and Prevention (CDC) has recommended administration of the TDaP in pregnant women immediately after delivery and before being discharging from hospital, in order to enhance maternal and neonatal immunity[4]. Immun-

ization of mothers against vaccine-preventable diseases is simple and reliable for protecting infants aged 3-6 months. However, neonatal immunization is usually unsuccessful due to lack of fully developed and functional immune system[6]. Therefore the best way to protect newborns during this period is to ensure that they receive the sufficient amount of maternal antibodies and also reduce any risk of exposure to the disease through immunization of their mothers with the booster dose of the vaccine when antibody levels decline.

Decision making process regarding maternal immunization requires credible information and knowledge about seroepidemiology of the infection in pregnant women. The aim of this study was to determine the seroprevalence of *B. pertussis* antibody among admitted pregnant women in Hamadan, Iran.

Methods

In this cross-sectional study, during a six-month period from October 2011 to March 2012, all pregnant women referred to Fatemieh Hospital, Hamadan, Iran were included in the study. The hospital is the main gynecology and obstetrics center in Hamadan, west of Iran, with the capacity to coverage of approximately 1,000,000 population. If for any reason patients did not agree with the research, they were excluded and replaced by the next patient individual. In this way, 288 consecutive pregnant women were enrolled.

This project was approved (No. D/P/16/35/9/432; 8 May 2012) by the Clinical Research Ethics Committee of Hamadan University of Medical Sciences, Hamadan, Iran. Informed consent was obtained from those individuals who agreed to participate in our research.

Three to five ml clotted blood sample was taken from each participant, and samples were immediately transferred to the -20 °C freezer until being analyzed for determining the serum level of *B. pertussis* antibody (IgG) using ELISA. According to the instructions provided by the manufacturer (IBL, Homburg, Germany), antibody levels higher than 24 U/ml were considered positive. The information collected from lab results were entered into the second part of every participant's initial questionnaire. The first part of the questionnaire covered demographic information, including age, place of residency living, occupation, education, the vaccination history of gestational age and childhood. Lab test results showing the concentration of *B. pertussis* antibody (IgG) (U/mL) using ELISA was entered into the second part of the questionnaire.

Finally, the data were analyzed using statistical package version 15, and a $P<0.05$ was considered statistically significant. The *t*-test was used for quantitative variables and Chi-square test for qualitative variables.

Results

A total of 288 pregnant women were entered in this study. The mean age was 26.8±5 years (range: 16-42 years). The mean gestational age was 5.7±2.1 months. Table 1 shows demographic characteristics of participants and their immunization records. Most of the pregnant women (43.8%) were in the second trimester of their pregnancy. Seventy-four percent of them were rural residents, and 96.9% were housewives. Of 288 pregnant women, 274 (95.2%) had a complete immunization record against *B. pertussis* and 103 (35.8%) had the protective anti-*Bordetella* antibody levels.

Table 1: Demographic characteristics and immunization records of 288 pregnant women

Characteristics	Number	Percent
Location		
Urban	213	74.0
Rural	75	26.0
Job status		
Housewife	279	96.9
Secretary or teacher	3	1.0
Other	6	2.1
Educational level		
Illiterate	16	5.6
Primary school	138	47.9
High school	100	34.7
Academic	34	11.8
Trimester		
First	49	17.0
Second	126	43.8
Third	113	39.2
Vaccination history		
Complete	274	95.2
Incomplete	7	2.4
Unknown	7	2.4
History of recent illness		
Yes	18	6.2
No	270	93.8

Table 2 shows the data resulted from comparing of demographic characteristics and immunization records between individuals with positive and negative serology. There were no significant differences between any of the demographic variables, vaccination record against *B. Pertussis* and recent history of pertussis infection in both serological groups.

Table 2: Comparison of demographic variables and immunization records of pregnant women according to seroprevalence status

Variables	Seropositive n=103 (%)	Seronegative n=185 (%)	*P* value
Location			0.220
Urban	68 (31.9)	145 (68.1)	
Rural	35 (46.7)	40 (53.3)	
Job			0.986
Housewife	100 (35.8)	179 (64.2)	
Secretary or teacher	1 (33.3)	2 (66.7)	
Other	2 (33.3)	4 (66.7)	
Education			0.275
Illiterate	5 (31.2)	11 (68.8)	
Primary school	57 (41.3)	81 (58.7)	
High school	32 (32.0)	68 (68.0)	
Academic	9 (26.5)	25 (73.5)	
Trimester			0.829
First	18 (36.7)	31 (63.3)	
Second	47 (37.3)	79 (62.7)	
Third	75 (66.4)	38 (33.6)	
Vaccination history			0.447
Complete	96 (35.0)	178 (65.0)	
Incomplete	4 (57.1)	3 (42.9)	
Unknown	3 (42.9)	4 (57.1)	
History of recent illness			0.427
Yes	8 (44.4)	10 (55.6)	
No	95 (35.2)	175 (64.8)	

Discussion

Although routine vaccination of children could play an important role in keeping children safe from pertussis infection, but, in the meanwhile it has changed the aged distribution pattern of the infection. In addition, clinical manifestation of the infection owing to the time-limited level of protective antibodies after immunization may have changed. Passive immunity can be developed through the transfer of readymade antibodies from maternal blood into the fetus through placenta. This immunity could protect newborns for few months following after birth, but after few months due to decline in the level of antibodies, they become susceptible to pertussis infection. In this vulnerable period, infected young people and adults can transmit the disease to those infants who have not been fully vaccinated and therefore, do not have the acceptable level of protection against pertussis infection[6,7].

Prior to implementation of preventive measures with *B. pertussis* acellular vaccine, the incidence of pertussis infection in any given area should be evaluated. A similar study was performed on female freshman medical students at Hamadan University of Medical Sciences and 47.6% of them had antibody levels against *B. pertussis*. High levels of antibody titer, especially in samples with 19 to 21 year of age group (82/725 U/ml) was indicative for of recent infection with *B. pertussis*. Although infection in adults is mild, but high prevalence of the disease among adults is alarming and a risk factor for serious illness as well as spreading the pertussis infection to newborns with greater potency and severity. Hence, some experts believe that to maintain immunity against the pertussis in adolescents and adults, a booster vaccine is needed to reduce prevalence of the infection and prevent the disease from spreading further[8,9]. Results from similar studies in other regions, reflect different protective levels of antibodies such as 33% in Spain[10], 55% in Japan[11], 88% in Slovenia[12], and 97% in Singapore[13]. Most of these studies have shown an increasing susceptibility to pertussis infection among adolescents and adults, also the need for a booster dose for adolescents and adults have been emphasized.

The latest study performed in China in 2011 has shown disappointing results, protective antibody levels against *B. pertussis* in 1616 young children and adolescents, aged from 2 to 20 years old, was only 6.6% and researchers have recommended a booster dose for young children and adolescents[14], Results from different serological studies performed during pregnancy, were also affected by the protective level of antibodies against pertussis infection in adult populations in those studies. Only 35.8% of the participants had a protective antibody level against *B. pertussis*, indicating that immunity and protection level against pertussis infection was low. Within demographic variables only a significant difference was observed among seropositive participants lived in rural areas with a history of recent pertussis infection who had higher levels of antibody titer compare to seropositive groups lived in urban areas. These differences can be attributed to the lower socioeconomic status and healthcare quality in rural areas. Therefore, rural populations are more likely to have higher incidence of *B. pertussis* infection among adolescents and adults.

The results showing low seroprevalence of antibody titer against *B. pertussis* form our in this study is similar with results from same studies performed worldwide. The study performed on 102 pregnant women in Russian, measured antibody levels of diphtheria, tetanus, and pertussis was measured. Accordingly over 91% of the cases had a protective antibody level against diphtheria and tetanus, but more than two-thirds of women were seronegative against pertussis; only 22.5% had antibody titer required for protection and 10.8% of cases had the acceptable antibody levels against *B. pertussis*. [15] In another study performed in the United States, serum antibody level against *B. pertussis* of 81 mothers, and their newborn infants was measured, and the results showed that only 21% of mothers and 26% of newborns had an acceptable level of antibodies required for protection[16].

Since low level immunity in newborns against *B. pertussis* is a sign of deficiency in maternal antibody level, therefore, a booster immunization to mothers during pregnancy may protect newborn infants in the few months after birth. Centers for disease control and prevention (CDC) has recommended a booster dose of diphtheria and tetanus toxoids, and as well as a booster dose of pertussis acellular vaccine right after delivery, and before being discharged from hospital to be given to mothers which helps in protecting them and their newborns against *B. pertussis* infection. The American College of Obstetrics and Gynecology has the same recommendations for its members[4].

Conclusions

Pregnant women have low levels of antibodies against *B. pertussis*. Booster dose injection of pertussis vaccine before or during pregnancy can stimulate newborn's immune response and gives them required protection against pertussis infection.

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Conflict of interest statement

The authors declare that have no conflicts of interest.

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