A rubella serosurvey in postpartum women in the three regions of Peru

Luis Suárez-Ognio,[1] *Ana Adrianzén,*[1] *Ana Ortiz,*[2] *Carlos Martínez,*[1] *Alvaro Whittembury,*[1] *Edwin Cabezudo,*[2] *Lucia de Oliveira,*[3] *Marilda M. Siqueira,*[4] *and Carlos Castillo-Solórzano*[5]

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ABSTRACT

Objective. *To determine the proportion of postpartum women aged 15–49 in Peru who are susceptible to rubella, in order to help address strategies to eliminate rubella and to prevent congenital rubella syndrome (CRS) in the country.*

Methods. *A cross-sectional survey was conducted during March and April 2003 in six main regional hospitals, in the three geographic regions (coast, mountain, and jungle) of Peru. For the postpartum women who provided written informed consent, a questionnaire was administered and a blood specimen was collected. Sera were tested for rubella immunoglobulin G (IgG) antibody, using a commercial enzyme-linked immunosorbent serologic assay (ELISA) kit. Univariate, bivariate, and multivariate analyses were carried out to assess risk factors for susceptibility.*

Results. *In total, 1 236 postpartum women were enrolled. The overall proportion of IgG-antibody negative women was 12.8% (95% confidence interval (CI): 10.9%–14.6%). Bivariate analysis found the following variables associated with susceptibility: living in the jungle region (odds ratio (OR) = 1.65; 95% CI: 1.13–2.42); age < 19 years (OR = 2.02; 95% CI: 1.35–3.03); being a housewife (OR = 1.69; 95% CI: 1.12–2.55); and having ≤ 11 years of education (OR = 2.12; 95% CI :1.20–3.75). Multivariate analysis found the following variables were associated with susceptibility: living in the jungle region (OR = 1.67; 95% CI: 1.13–2.46); age < 19 years (OR = 1.62; 95% CI: 1.07–2.47); having < 4 children born alive (OR = 1.85; 95% CI: 1.00–3.40); and having ≤ 11 years of education (OR = 2.07; 95% CI: 1.16–3.71).*

Conclusions. *The proportion of postpartum women at the study sites who were found to be susceptible to rubella was 12.8%, placing Peru among the countries facing a moderate level of risk for the occurrence of CRS cases. The findings suggest the need to also provide the rubella vaccine to other population groups, especially women of childbearing age.*

Key words Rubella; rubella syndrome, congenital; disease susceptibility; seroepidemiologic studies; immunization; Peru.

[1] General Office of Epidemiology, Ministry of Health, Lima, Peru. Send correspondence to: Luis Suárez Ognio, General Office of Epidemiology, Ministry of Health, Camilo Carrillo #402, Jesús María – Lima 11, Peru; telephone: (51-1) 4335428/433-0081/330-1534; fax: (51-1) 332-3482; email: lsuarez@oge.sld.pe; alwhittvla@yahoo.

[2] National Institute of Health, Ministry of Health, Lima, Peru.

[3] Pan American Health Organization, Lima, Peru.

[4] Fiocruz, Ministry of Health, Rio de Janeiro, Brazil.

[5] Pan American Health Organization, Washington, D.C., United States of America.

Rubella is an infectious viral disease that commonly occurs in childhood, when it is usually benign (1). However, if rubella occurs during the early months of pregnancy, the virus may

infect the fetus and result in fetal death, leading to miscarriage or stillbirth, or to an infant with congenital rubella syndrome (CRS). CRS is characterized by multiple congenital malformations, including defects of the brain, heart, eyes, and ears. The first description of CRS was made by Australian ophthalmologist N. McAlister Gregg. Following a rubella epidemic in 1940, Gregg noted an increase in the number of infants with cataracts, heart disease, and failure to thrive. Most of the mothers gave a history of rubella infection in the early months of pregnancy, and Gregg theorized that maternal rubella infection had affected the development of the fetus (2). However, it was not until the rubella pandemic of the early 1960s that CRS received widespread recognition. The incidence of congenital malformations is 85% or higher if the mother is infected with rubella virus during the first trimester of pregnancy; sensorineural hearing deficit may occur in infants whose mothers were infected up to week 20 of pregnancy (3).

Rubella has a worldwide distribution, and in the prevaccine era, rubella epidemics occurred every five to nine years. During an epidemic in 1964–1965 in the United States of America (USA), there were an estimated 12.5 million rubella cases, 11 250 fetal deaths, and more than 20 000 cases of CRS (3).

In Peru, rubella is an endemic disease (Figure 1). There is a higher incidence of rubella in spring and summer months (October–February). During endemic periods, the mean annual rubella incidence was 5 per 100 000 inhabitants, while during outbreaks the mean annual rubella incidence rose to 25 per 100 000 inhabitants (4). Since 1999 in Peru, combined surveillance for measles and rubella has been conducted, with laboratory backup. The Measles-Rubella Surveillance Protocol, elaborated by the General Office of Epidemiology, states that every patient with fever and maculopapular rash illness must be investigated by completing the measles-rubella surveillance worksheet and obtaining a serum sample collected within 30 days of rash onset. Laboratory confirmation of rubella is by a positive rubella immunoglobulin M (IgM) enzyme-linked immunosorbent serologic assay (ELISA) test or by epidemiological linkage to a laboratory-confirmed rubella case. A clinically confirmed case is a suspected case that has rubella clinical signs and symptoms but doesn't have laboratory confirmation. During 2000, 2001, and 2002 there were 4 993, 3 864, and 1 571 suspect rubella cases investigated, of which 1 967 (39.4%), 1 405 (36.4%), and 424 (27.0%) were confirmed as rubella (4). During 2000–2002, confirmed rubella cases were identified in every region of the country. The proportion of confirmed rubella in persons 15 years of age or older was 10.6%, 13.8%, and 18.6% in 2000, 2001, and 2002, respectively.

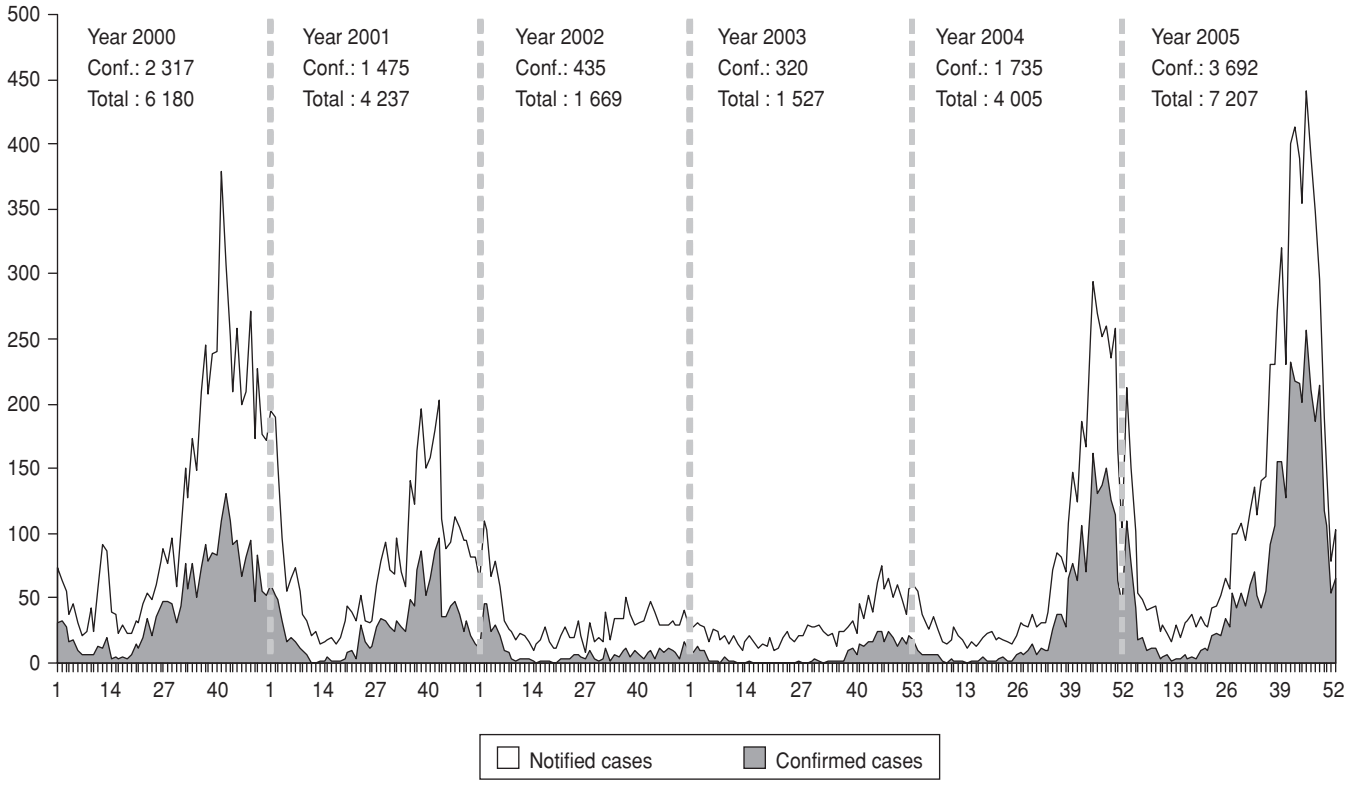
There is considerable evidence documenting the burden of CRS in Peru. During 1998–2000, a study in six schools for hearing-impaired and/or blind children found that 24 (6.6%) of 364 deaf and/or blind children younger than 12 years of age had probable or confirmed CRS (5). Also during 1998–2000, a retrospective review of 91 102 clinical records from children < 12 years of age at 17 hospitals in Peru found 57 children with probable or confirmed CRS (6). Since 2004 the Peruvian Ministry of Health, with technical and financial support from the Pan American Health Organization (PAHO) and the World Health Organization (WHO), has implemented a CRS sentinel surveillance system in 14 health facilities of nine regions. During 2005, the system identified a total of 20 infants with congenital rubella transmission, of which 8 were CRS-confirmed cases (7). The cases were found in the coast and mountain regions of Peru, but not in the country's third region, the jungle.

Many countries in the Americas have conducted rubella serosurveys among women of childbearing age, and the results show that rates of susceptibility vary widely (8–12). Other studies have found that teachers, students, and health workers are at risk of being infected with rubella and that they may play an important role in the transmission of the virus (13–16). Only two rubella serosurveys have been reported from Peru. During 1967–1968 a multicountry study in the Americas assessed rubella susceptibility in 297 Peruvian women of childbearing age: 22% were seronegative in Lima, the capital of Peru, compared with 40% in a remote jungle setting (10). In contrast, the same study found that in Argentina, Brazil, Chile, and Uruguay there were no appreciable differences between rural and urban areas. During 1998, a serosurvey at the Cayetano Heredia Hospital, in Lima, found that 7.6% of 172 pregnant women were seronegative for rubella (17).

In the Region of the Americas, a goal of measles elimination by 2000 was established and implemented. As progress was made in measles elimination, there was increased interest in rubella vaccine, which is safe, effective, and a cost-beneficial means of controlling rubella and preventing CRS (3, 18, 19). In September 2003, the Directing Council of PAHO approved a resolution calling for Member States to eliminate rubella and CRS by the year 2010 (20, 21). To eliminate both rubella and CRS, the PAHO strategy calls for universal vaccination of infants, high-quality surveillance, and immunization of adults, particularly women in their childbearing years.

In June 2003, Peru introduced rubella vaccine in its national immunization program. The schedule calls for a dose of measles-mumps-rubella (MMR) vaccine for children at age 12 months. MMR vaccine coverage of infants in 2004 was 89% (provisional data as of 10 February 2005, according to the General Office of Statistics and Computer Science, Ministry of Health). Thus, Peru has started on the pathway to rubella and CRS elimination, but there is still the need to consider rubella vaccine introduction for adults. In Peru, there is not enough information on the proportion of women of childbearing age who are susceptible to rubella, or on potential risk factors for rubella susceptibility. Such information is needed to address strategies for rubella elimination and CRS prevention. Therefore, in six main regional hospitals of Peru, representing

FIGURE 1. Notified and confirmed (conf.) rubella cases by epidemiological week, with year total, Peru, 2000–2005[a]



[a] ***Source:*** General Office of Epidemiology, Ministry of Health, Measles Elimination Surveillance System database.

the three geographic areas of the country, a survey of rubella immunoglobulin G (IgG) antibody was conducted among postpartum women aged 15–49 years.

METHODS

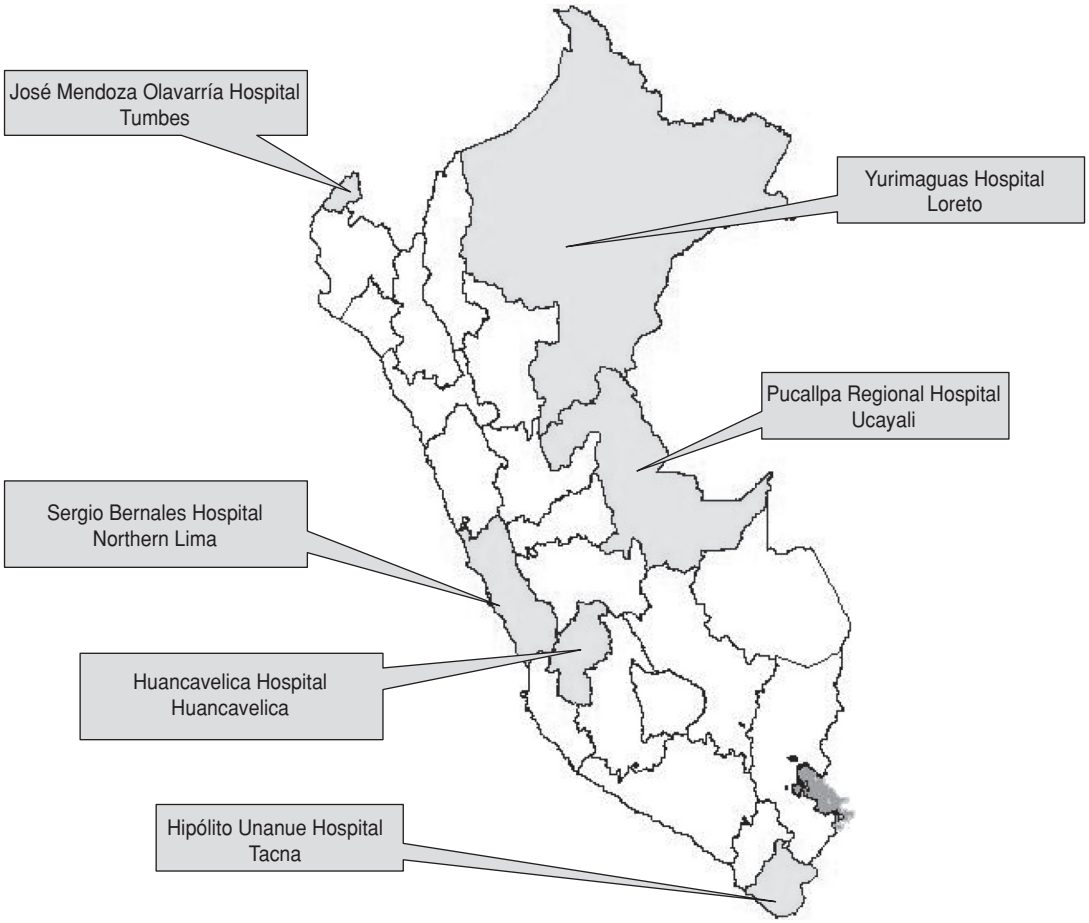
During March and April 2003 a cross-sectional rubella serosurvey was conducted in six main regional hospitals in the three geographic regions of Peru. The survey was based on WHO guidelines (22). During the study period, postpartum women aged 15–49 years in the obstetrical wards of the six hospitals were informed about the study and invited to participate. Women who provided written informed consent were enrolled. For each study-participant, a trained health worker administered a standard study questionnaire, and a qualified laboratory technician obtained a 5-mL blood sample.

The study protocol was reviewed and approved by the Committee on Ethics of the National Institute of Health, Lima, Peru, and the Secretariat Committee on Research involving Human Subjects of the World Health Organization, Geneva, Switzerland.

One main national hospital and five main regional hospitals were selected based on the annual number of obstetrical deliveries, availability of laboratory staff, willingness to participate in the study, and representativeness of the three different geographic regions of Peru. The six hospitals were: (1) Sergio Bernales Hospital (national hospital), Northern Lima department, central coast; (2) Hipólito Unanue Hospital, Tacna department, southern coast; (3) José Mendoza Olavarría Hospital, Tumbes department, northern coast; (4) Pucallpa Regional Hospital, Ucayali department, jungle; (5) Yurimaguas Hospital, Loreto department, jungle; and (6) Huancavelica Hospital, Huancavelica department, mountain (Figure 2). A second hospital located in a mountain area was selected, but was unable to complete the study due to disastrous flooding that produced devastating mudslides. All five of the department hospitals serve as reference facilities for patients coming from other hospitals within the political department, and the national hospital serves as a reference facility for patients coming from any other hospital in the country.

Blood specimens were centrifuged, serum separated, and refrigerated at 2 ºC to 8 ºC. Specimens were shipped by express courier in cold boxes from the study hospitals to the National Institute of Health, Lima, where they were stored at –20 ºC until analysis. Rubella IgG antibody tests were con-

FIGURE 2. Map showing geographical location, by department, of the six main hospitals participating in a rubella serosurvey, Peru, March–April 2003



ducted with a commercial ELISA kit (Rubenostika IgG ELISA, bio-Mérieux, Lyon, France). Rubella IgG levels of 10 International Units/mL or higher were considered positive. Fiocruz, in Rio de Janeiro, Brazil, served as the reference laboratory for this study.

A database was prepared using Epi Info, version 6.04 (Centers for Disease Control and Prevention, Atlanta, Georgia, USA), and the statistical analyses were performed with SPSS version 10.0 (SPSS Inc., Chicago, Illinois, USA). The variables included in the study were: hospital, area of residence (urban or rural), geographic region (coast, mountain, or jungle), level of education, occupation, history of working with children (that is, being paid for taking care of or teaching children), number of pregnancies, previous vaccination against rubella, history of previous rubella, and contact with someone with rubella. For each participant the socioeconomic status was assessed according to the poverty line method of the National Fund for Social Development and Compensation of Peru, which classifies the population into five socioeconomic levels: extremely poor, very poor, poor, middle class, and upper class (23). We classified the study population in two general groups: poor (extremely poor, very poor, and poor), and nonpoor (middle class and upper class). All variables were tested using a 95% confidence interval (CI) (α error = 0.05). Univariate analysis of data was performed using central tendency statistics for the numeric variables and summary statistics for the qualitative variables. Women with a negative ELISA test for rubella IgG antibodies were classified as susceptible, and those with positive ELISA test for rubella IgG antibodies, as immune. The proportion of all the women studied who were susceptible was determined. Bivariate analysis was used to measure the strength of the association between variables, using the odds ratio (OR) and the chi-square test. For quantitative variables, Pearson correlation was used. After these procedures, multivariate analysis was conducted, using logistic regression to control confounding factors and to obtain the adjusted ORs.

RESULTS

A total of 1 236 post-partum women consented to participate in the study. The median age was 24 years (in-

terquartile range = 10). There was no age difference for the women by geographic region or by area of residence. But there was an age difference between participants with more than 11 years of education and the ones with 11 or fewer years (26.8 vs. 25.2 years; $P = 0.001$). As expected, age was directly correlated with the obstetric history (pregnancies: $r = 0.667$, $P < 0.0001$; children born alive: $r = 0.651$, $P < 0.0001$; abortions: $r = 0.307$, $P < 0.0001$). In total, 89.1% of participants came from urban areas and 10.9% from rural areas. In terms of their educational level, 80.0% had a high school or university education, and 20.0% had an elementary school education or no education. With respect to occupation, 71.2% were housewives; 12.8% were traders or laborers, and 7.2% were professionals, health care workers, or clerks. The rest were students (3.5%), housekeepers (3.2%), or had another occupation (2.3%). The median number of children born alive was 2 (interquartile range = 2). Among the participants, 525 women (42%) had 1 child, 479 women (39%) had 2 or 3 children, 163 women (13%) had 4 or 5 children, 48 women (4%) had 6 or 7 children, and 21 (2%) had 8 to 12 children.

Overall, the proportion of rubella IgG-antibody negative women was 12.8% (95% CI: 10.9%–14.6%) (Table 1). Huancavelica Hospital had the lowest proportion of susceptible women (4.3%), while Yurimaguas Hospital had the highest proportion (22.7%). Susceptibility rates differed by geographic region: mountain region, 4.3% (95% CI: 0.0%–10.0%); coast region, 11.9% (95% CI: 9.8%–14.0%); and jungle region, 17.7% (95% CI: 13.0%–22.5%). In urban areas the susceptibility was 12.6% (95% CI: 10.7%–14.6%), compared with 14.1% (95% CI: 8.2%–20.0%) in rural areas, but this difference was not statistically significant ($P = 0.622$). Among poor women, the proportion who were susceptible was 15.4% (95% CI: 11.5%–19.3%), compared with 11.8% (95% CI: 9.7%–13.9%) among nonpoor women; however, this difference was not statistically significant ($P = 0.093$).

Among women 15–19 years of age, a higher proportion were susceptible (18.2%, 95% CI: 13.5%–22.8%) than was true for other age groups ($P = 0.001$) (Table 2). In terms of education, the proportion susceptible was highest among women with elementary education (16.8%, 95% CI: 12.1%–21.6%) and lowest (5.6%, 95% CI: 0.3%–10.8%) among women with university education ($P = 0.017$). When comparing women with more than 11 years of studies (13.9%, 95% CI: 11.8%–16.0%) with those with 11 or fewer years of study (7.1%, 95% CI: 3.5% –10.7%), the P value was more significant ($P = 0.0086$). Health care workers had the lowest level of susceptibility (0.0%) among occupation groups, while laborers had the highest (20.6%, 95% CI: 7.0%–34.2%). Susceptibility among women working with children (13.6%, 95% CI: 3.5%–23.7%) did not differ significantly from susceptibility among women not working with children (12.8%, 95% CI: 10.9%–14.7%) ($P =$

TABLE 1. Proportion of postpartum women 15–49 years of age who are susceptible to rubella, by selected variables, in a serosurvey in six main hospitals of Peru, March–April 2003

Variable	No. of women enrolled	Susceptibility proportion (%)	95% confidence interval
Name of hospital/Location (political department, geographic region)			
José Mendoza (Tumbes, northern coast)	188	16.5	11.2–21.8
Sergio Bernales (northern Lima, central coast)	472	11.4	8.6–14.3
Hipólito Unanue (Tacna, southern coast)	281	9.6	6.2–13.1
Pucallpa (Ucayali, jungle)	182	15.9	10.6–21.3
Yurimaguas (Loreto, jungle)	66	22.7	12.6–32.8
Huancavelica (Huancavelica, mountain)	47	4.3	0.0–10.0
Area of residence			
Urban	1 101	12.6	10.7–14.6
Rural	135	14.1	8.2–20.0
Level of education			
None	9	0.0	—
Primary	238	16.8	12.1–21.5
Secondary	791	13.1	6.6–19.6
Higher	198	7.1	3.5–10.6
Socioeconomic status			
Extremely poor	6	16.7	0.0–46.5
Very poor	14	21.4	0.0–42.9
Poor	311	15.1	11.1–19.1
Middle class	895	11.8	9.7–13.9
Upper class	10	10.0	0.0–2.9
Total/Overall	1 236	12.8	10.9–14.6

TABLE 2. Proportion of postpartum women 15–49 years old who are susceptible to rubella, by age group, in a serosurvey in six main hospitals, Peru, March–April 2003

Age group (yr)	No. of women enrolled	Susceptibility proportion (%)	95% confidence interval
15–19	264	18.2	13.5–22.8
20–24	361	11.9	8.6–15.3
25–29	279	12.2	8.4–16.1
30–34	191	11.0	6.6–15.4
35–39	116	10.3	4.8–15.9
40–44	23	0.0	—
45–49	2	0.0	—
Total/Overall	1 236	12.8	10.9–14.6

TABLE 3. Logistic regression model for variables associated with rubella susceptibility in postpartum women in six main hospitals of Peru, 2003

Model	Coefficient			Odds ratio		
	Point estimate	Standard error	*P*	Point estimate	95% confidence interval	
					Lower	Upper
Years of education (≤ 11, > 11)	0.728	0.298	0.014	2.071	1.156	3.711
Children born alive (< 4, ≥ 4)	0.613	0.311	0.049	1.846	1.004	3.395
Jungle region	0.512	0.197	0.009	1.669	1.133	2.458
Age (< 19 years, ≥ 19 years)	0.483	0.214	0.024	1.621	1.065	2.468

0.876). Nine participants (0.7%) reported previous clinical rubella before the survey, and 8 of the 9 (88.9%) were rubella IgG-antibody positive. Nineteen participants (1.5%) reported previous contact with persons with rubella, and 16 of the 19 (84.2%) were rubella IgG-antibody positive. Thirteen participants (1.1%) reported they had been vaccinated against rubella, and all were rubella IgG-antibody positive.

Bivariate analysis showed the variables significantly associated with rubella susceptibility were: living in the jungle (OR = 1.65; 95% CI: 1.13–2.42); age < 19 years (OR = 2.02; 95% CI: 1.35–3.03); being a housewife (OR = 1.69; 95% CI: 1.12–2.55), and having ≤ 11 years of education (OR = 2.12; 95% CI: 1.20–3.75). For the logistic regression model, at the beginning, a total of 13 variables were included: age (< 19 years, ≥ 19 years), pregnancies, children born alive (< 4 children, ≥ 4 children), abortions (yes, no), geographic region as three different variables (jungle, mountain, and coast), working with children, working at home, years of education (≤ 11 years, > 11 years), history of rubella, history of rubella contact, and rubella vaccination. As the objective of the analysis was to obtain adjusted ORs, the variables with the lowest level of significance were removed one by one, while checking the coefficients and the exponential values of the remaining ones. The final model (Table 3) addressed the following variables as significantly associated with rubella susceptibility: age < 19 years (OR = 1.62; 95% CI: 1.07–2.47); living in the jungle (OR = 1.67; 95% CI: 1.13–2.46); < 4 children born alive (OR = 1.85; 95% CI: 1.00–3.40); and ≤ 11 years of education (OR = 2.07; 95% CI: 1.16–3.71).

DISCUSSION

This study found that the overall rubella susceptibility proportion for women of childbearing age in the six study sites in Peru was 12.8%. This proportion is much lower than the 31% susceptibility proportion reported by Dowdle et al. in 1968 based on a sample of 297 women (10). The lower susceptibility proportion this study found in 2003 may reflect the impact of large rubella outbreaks in Peru during the three years prior to the study. Although the 1968 study found significant differences in rubella susceptibility between urban and rural areas, our study in 2003 did not. However, our study did find significantly higher rates of susceptibility among women living in jungle areas compared with women in other parts of the country, and this may reflect a lower population density and less frequent travel of jungle residents to other areas. Although the proportion of childbearing women who were susceptible was dramatically lower than the proportion in 1968, the 12.8% susceptibility level that we found is nevertheless high enough to permit rubella outbreaks and endemic transmission, which may indicate a moderate risk for the presentation of CRS cases (9, 24). Moreover, the trends with rubella cases in our country show a shorter interepidemic period (about two years) than has been reported in other nations (1), and this may indicate an increased risk for CRS in Peru.

A global review of rubella serosurveys conducted among women of childbearing age in developing countries found more than 100 serosurveys in 45 developing countries prior to the introduction of rubella vaccine (9). The proportion of women seronegative to rubella was less than 10% in 13 countries, 10%–24% in 20 countries, and 25% or higher in 12 countries. Thus, the 12.8% susceptibility proportion in our study fits into the middle range of rubella susceptibility for women in studies from around the world.

We assessed rubella immunity in relation to self-reported history of rubella, rubella exposure, and rubella vaccination. Among women who reported they had not had rubella, 87.5% were rubella IgG-antibody positive. This is an expected finding, since it is well known that almost half of rubella infections are asymptomatic (1). Thirteen participants (all rubella IgG-antibody positive) reported they had received rubella vaccine, although this was not available through the public sector health services at the time of the study.

Our study has several limitations. This study was based on convenience samples from six main hospitals, as a full-scale population-based survey was felt to be operationally too difficult. Some known selective factors suggest the direction of the bias introduced by the sampling strategy. The proportion of women from urban areas in the study (80%) was higher than the 72% national average (25).

The geographic region of residence differs widely from the national population distribution: 941 (76.1%) of the participants lived in the coast region, 47 (3.8%) in the mountain region, and 248 (20.1%) in the jungle region, while the national distribution is 52.1%, 36.9%, and 11.0%, respectively. Because it was hospital-based, the study was unable to assess the rubella immunity of the 41% of Peruvian women who give birth at home (24). Those women are more likely to have the characteristics associated with susceptibility, in terms of age, level of education, and geographic region. Therefore, the rates we found might be underestimated. Despite the limitations in internal and external validity, our rough estimates constitute invaluable information to support decisions relating to immunization efforts in Peru. Our data may also pave the way to future assessment of impact based on probabilistic samples both for planning and evaluation of immunization strategies.

Despite widespread rubella virus circulation in the three years prior to the study—due to a national rubella outbreak in the years 2000–2002—a substantial proportion of the adult women studied were found to still be susceptible to this disease. These women remain at risk of delivering an infant with CRS if infected with rubella virus in a subsequent pregnancy. The CRS sentinel surveillance system has reported cases from both the coast and mountain regions, which, surprisingly, are the regions with the lower rubella susceptibility proportions (11.9% and 4.3%, respectively) in our study. It indicates that there may always be risk for CRS while the rubella virus is circulating in a population, no matter the proportion of susceptible women.

The Ministry of Health of Peru introduced rubella vaccine (in the form of MMR vaccine) for children at age 12 months in June 2003 and achieved high coverage. The findings of this serosurvey suggest the need to also provide rubella vaccine to other population groups, especially women of childbearing age.

From October 2006–November 2006, a national vaccination campaign was carried out by the Ministry of Health. Almost 20 million people from 2–39 years of age were vaccinated (approximately 72.7% of Peru's total population). From January 2007 to the present (May 2007), there have been no confirmed cases of rubella reported in the surveillance system. The challenge now is to maintain a high level of vaccination coverage among 1 year old children.

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RESUMEN

Estudio serológico de rubéola en mujeres recién paridas en las tres regiones de Perú

Objetivo. Determinar la proporción de mujeres recién paridas de 15–49 años de edad susceptibles a la rubéola en Perú, a fin de contribuir a establecer estrategias para eliminar la rubéola y evitar el síndrome de rubéola congénita (SRC) en el país.

Métodos. Se realizó un estudio transversal en marzo y abril de 2003 en seis hospitales regionales principales de tres regiones geográficas (costa, sierra y selva) de Perú. A las mujeres recién paridas que dieron su consentimiento informado por escrito se les aplicó un cuestionario y se les tomó una muestra de sangre. La detección serológica de anticuerpos de la clase IgG contra rubéola se realizó mediante un ensayo inmunoenzimático comercial tipo ELISA. Se realizaron análisis con una, dos y múltiples variables para evaluar los factores de riesgo de ser susceptible a la enfermedad.

Resultados. En total participaron 1 236 mujeres recién paridas. La proporción de mujeres negativas a anticuerpos IgG contra rubéola fue de 12,8% (intervalo de confianza de 95% [IC95%]: 10,9% a 14,6%). Según el análisis bifactorial, las variables asociadas con la vulnerabilidad a la enfermedad fueron: vivir en la región de la selva (razón de posibilidades [*odds ratio*, OR] = 1,65; IC95%: 1,13 a 2,42); tener menor de 19 años de edad (OR = 2,02; IC95%: 1,35 a 3,03); ser ama de casa (OR = 1,69; IC95%: 1,12 a 2,55); y tener 11 años o menos de educación (OR = 2,12; IC95%: 1,20 a 3,75). Las variables asociadas con la vulnerabilidad a la enfermedad según el análisis multifactorial fueron: vivir en la región de la selva (OR = 1,67; IC95%: 1,13 a 2,46); tener menos de 19 años de edad (OR = 1,62; IC95%: 1,07 a 2,47); tener menos de 4 niños nacidos vivos (OR = 1,85; IC95%: 1,00 a 3,40); y tener 11 años o menos de educación (OR = 2,07; IC95%: 1,16 a 3,71).

Conclusiones. En la zona estudiada, la proporción de mujeres recién paridas susceptibles a la rubéola fue de 12,8%, lo que coloca a Perú entre los países con riesgo moderado de tener casos de SRC. Estos resultados indican la necesidad de vacunar también contra la rubéola a otros grupos de la población, especialmente a las mujeres en edad de procrear.

Palabras clave Rubéola, síndrome de rubéola congénita, susceptibilidad a enfermedades, estudios seroepidemiológicos, inmunización, Perú.