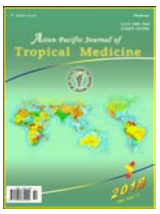

IF: 0.925

Asian Pacific Journal of Tropical Medicine

journal homepage: www.apjtm.org

doi: 10.4103/1995-7645.223561

Seroprevalence of varicella zoster virus in Colombo district, Sri Lanka

Hathshya M Munasingha[1]✉, Ananda Amarasinghe[2], Neelika G Malavige[3], Nalini Sathiakumar[1]

[1]*Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, USA*
[2]*Public Health Specialist / Medical Epidemiologist, Office–WHO Manila, Philippines*
[3]*Department of Microbiology, University of Sri Jayawardenapura, Sri Lanka*

ARTICLE INFO

Article history:
Received 5 September 2017
Received in revised form 27 October 2017
Accepted 15 November 2017
Available online 2 January 2018

Keywords:
Colombo district
Seroprevalence
Sri Lanka
Vaccine
Varicella

ABSTRACT

Objective: To determine the seroprevalence of varicella zoster virus (VZV) antibodies among the population residing in the Colombo district of Sri Lanka. **Methods:** A cross-sectional population-based study was conducted which included 1 258 participants. Blood samples were collected and questionnaires administered to obtain sociodemographic information and history of varicella and/or herpes zoster. Serum samples were assayed for VZV IgG antibodies using a commercial enzyme-linked immunosorbent assay kit. **Results:** Overall, the seroprevalence was 54.2% (95% *CI* = 51.5% 57.0%). Children below 1 year of age were seronegative, and only about 20.0% of children between 1 and 10 years of age were seropositive. Seropositivitiy increased with age and by the age of 40 years 74.3% were seropositive. Among women of childbearing age, the overall seroprevalence was about 62.0% (95% *CI* = 57.7%–66.1%) but was low 37.0% in the 15–19 age group. **Conclusion:** In this population, 45.8% lacked natural immunity against varicella. Of women of childbearing age, 39.9% lacked immunity and in the subgroup of women 15–19 years of age, 63.0% women lacked immunity. In light of the country's success with the control and high coverage of other vaccine preventable diseases and that the vaccine is available in the private sector, the inclusion of varicella vaccine in the national immunization program may be considered.

1. Introduction

Varicella (chickenpox) is an acute infectious disease caused by primary infection with the alpha-herpes varicella-zoster virus (VZV)[1]. Following primary infection, VZV persists in sensory nerve ganglia, and reactivation may occur several years later presenting as herpes zoster (shingles)[2,3]. Varicella has a worldwide distribution. In temperate climate, the incidence of varicella is highest among children 5–9 years of age. On the other hand, in tropical and subtropical climates, the incidence is highest among adolescents and young adults[4].

Humans are the only source for VZV; transmission occurs via contact with persons with varicella or herpes zoster or airborne spread from respiratory secretions or skin lesions of a person with varicella. The incubation period is usually 14–16 d[2,3]. The clinical course of varicella in healthy children is generally mild and self-limited[2-4]. The disease is characterized by a pruritic maculopapular rash that progresses to vesicular lesions before crusting. The rash usually appears first on the head, followed by the trunk and extremities; the highest concentration of lesions is on the trunk. Lesions may also occur on mucous membranes of the oropharynx, respiratory tract, vagina, conjunctiva and the cornea[1-4]. Complications include secondary bacterial infection of skin lesions, pneumonia, encephalitis, cerebellar ataxia, Reye syndrome and death; the risk of complications is greater in immunocompromised persons, infants younger than 1 year of age and persons more than 15 years of age[3,4]. In 2010, the global estimate for varicella deaths was 6 800[5].

Immunity following varicella infection is long-lasting and second occurrences are rare. Serologic tests are available for confirmation of the disease; single IgG tests are used to determine the immune status of persons. Persons with past exposure to VZV either

✉First and corresponding author: Hathshya M Munasingha, Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, 1665 RPHB, Univ. Blvd., Birmingham, Alabama, 35294, US.
E-mail: hathshya@uab.edu; munasinghahathshya@gmail.com

How to cite this article: Hathshya M Munasingha, Ananda Amarasinghe, Neelika G Malavige, Nalini Sathiakumar. Seroprevalence of varicella zoster virus in Colombo district, Sri Lanka. Asian Pac J Trop Med 2018; 11(1): 53-57.

through illness, asymptomatic infection or by vaccination become seropositive for antibodies to the VZV. Seronegative persons are at risk for VZV infection as adults, who usually have severe disease[3]. Varicella is a vaccine-preventable disease. In industrialized countries, varicella vaccine is included in the national immunization programs. The epidemiology, public health and socioeconomic impact with scarce resources have limited its inclusion in national vaccination programs in developing countries[6].

Sri Lanka, a lower middle income country in South Asia[7], is an island with a population of about 20 million[8]. The country provides universal health care free of cost and scores higher than the regional average having a high life expectancy (male, 72 years; female, 78.6 years) and low maternal (22/100 000 live births) and infant mortality (9.9/1 000 live births)[9] than other countries in the South Asian region.

The impact of varicella infection on the health care system appears to be high. Data from the Infectious Disease Hospital in Sri Lanka for the period 2000–2001 indicate that 65% of admissions were due to VZV infection (91% varicella and 9% herpes zoster); the mean age was 33 years (range, 3 d–94 years). The case fatality rate was 4.1% (41/989) for varicella[10]. The country has a strong public health program controlling most communicable diseases. Although varicella surveillance began in 2005[11], varicella vaccine is not included in the national immunization program[12].

Data on VZV seroprevalence in the country are limited. Only three previous studies reported seropositive status among selected population groups. A population-based survey conducted in the Colombo district in 2000 of 913 participants (0–60 years) found a seroprevalence of 36.0%[13]. Another survey among 451 medical and engineering university students in Peradeniya in 2003 reported a seroprevalence of 50.9%[14]. A third survey of 271 school children (12–19 years) in 2005 in Kandy district reported a seroprevalence of 34.0%[15]. Additional data on VZV seroprevalence will be useful in guiding recommendations for varicella vaccination in the country. In two companion papers, we discussed: incidence and costs associated with varicella infection; and predictive value of self-reported varicella infection.

2. Materials and methods

2.1. Ethical review

The study was approved by the Ethics Committee of University of Colombo, Sri Lanka.

2.2. Study setting

Colombo district is one of three (Colombo, Gampaha and Kalutara) districts of the western province in Sri Lanka with a land area of 676 km^2. It has a population of about 2.3 million with a population density of 3 300 / km^2[8]. The district is divided into urban (72.1%), rural (27.6%) and estate (0.3%) sectors. The national health system has divided districts in the country into smaller health administrative units for ease of rendering health care. Each district is divided into Medical Officer of Health areas; that is the area that is covered by one or more medical officers. The Medical Officer of Health areas are further divided into 'Public Health Inspector' and 'Public Health Midwife' areas. 'Grama Niladari' is the smallest local government administrative unit under a 'Public Health Midwife' area. The study was carried out during 2013 in six of the 12 Medical Officer of Health areas in the Colombo district.

2.3. Study design and study population

This field survey was designed as a cross-sectional, age-stratified VZV seroprevalence study of the Colombo district population of all ages and both genders. To be included in the study, participants had to be resident for at least 6 months in Colombo district. The sample size was calculated based on multistage cluster sampling with probability proportionate to size; one 'Grama Niladari' area was considered as a cluster. The estimated sample size was 1 230. To allow for nonparticipation, 1 300 subjects were selected and invited to participate in the study. Of these, 1 258 participated (participation rate, 96.8%).

2.4. VZV seroprevalence

The detection of VZV immunoglobulin (IgG) antibodies by VZV IgG enzyme-linked immune-sorbent assay (ELISA) is an indicator of previous VZV infection. VZV IgG is detectable within the first 4 d of clinical symptoms and thereafter remains detectable for decades. Seropositive status indicates immunity and seronegative status indicates susceptibility to VZV. To determine seropositive status for this study, serum samples were tested using a commercially available validated VZV ELISA-IgG antibody test kit with a reported sensitivity of 99.4% and specificity of 97.0%[16].

2.5. Data collection

The study was embedded in the national health care system. Subjects were recruited by government public health midwives in their homes and invited to participate. If they agreed to participate, a signed informed consent was obtained; in the case of infants or children, informed consent was obtained from parents or guardians. The midwife then administered a questionnaire that elicited demographic information, collective household income and past history of varicella and herpes zoster. A government public health nurse collected a blood sample which was then transported to a government university microbiology laboratory for testing.

2.6. Data analysis

Seroprevalence was computed as the number of positive cases divided by the number of examined sera with associated 95% confidence intervals (95% *CI*). Seroprevalence was computed for age-, gender- residence-and social economic status (SES)-specific strata. Monthly household income information was used to classify subjects into three SES groups (low: < 20 000 Sri Lankan Rupees; medium: 20 000–40 000 Rupees; and high: > 40 000 Rupees). The chi-square test was used to determine differences in seroprevalence among subgroups. Data were analyzed using SPSS.

Table 1 presents the demographic characteristics of the study group. The mean age was 31 years (standard deviation, 19.2 years) with a range of 6 months–87 years. Study subjects were predominantly female (70.0%), and 60.2% lived in urban areas. 76.2% of study subjects had secondary school to pre-university education. 65.1% belonged to the low SES group. Most (91.1%) subjects were of

Sinhala ethnicity.

Table 1
Sociodemographic characteristics of study population.

Characteristic	*n*	Percentage (%)
Total	1 258	100.0
Age (years)a		
< 5	96	7.6
5–14	190	15.1
15–45	650	51.7
46–59	204	16.2
≥ 60	118	9.4
Sex		
Female	883	70.2
Male	375	29.8
Residence		
Urban	757	60.2
Rural	501	39.8
Education		
Lower than primary	266	21.1
Secondary/pre-university	958	76.2
Diploma/degree	34	2.7
Socioeconomic status		
Low	819	65.1
Medium	361	28.7
High	78	6.2
Ethnicity		
Sinhala	1 146	91.1
Moor	74	5.9
Tamil	38	3.0

[a]The mean ± SD of age was (31.0±19.2) years with median of 29.0 years and range of 0.5–87.0 years.

3. Results

VZV antibodies were detected in serum samples from 682 of 1 258 subjects, yielding an overall seroprevalence of 54.2% (95% *CI* = 51.5%–57.0%) (Table 2). Seropositivity was 0.0% for children below 1 year of age and increased to 9.7% in the 1–4 year age group and 10.3% in the 5–9 year age group. Thereafter, the antibody prevalence increased about 3-fold to 34.5% in the 10–19 year age group, and then doubled to 63.1% among the 20–39 year age group. From 40 years onwards, about 75% were seropositive for VZV. Statistically significant differences were noted for gender and educational level: males had a lower seropositivity compared to females (43.2% vs. 58.8%, *P*<0.000 1); and seropositivity was lower among the subgroup with only primary education compared to those with secondary school upwards to a college degree education (25.6% vs. 62.0%, *P*<0.000 1). Differences by urban/rural residence or SES were unremarkable.

Table 3 provides seropositivity status among the subgroup of women of childbearing age (15–45 years). The overall seropositivity was 62.0% (95% *CI* = 57.7%–66.1%). Similar to patterns in the overall group, seropositivity was low in the 15–19 age group (37.0%) and then rose to 60.6% in the 20–24 age and 67.3% in the 25–29 age group; seropositivity then slightly tipped down to 63.7% in the 30–34 age group and 64.3% in the 35–39 age group. Thereafter, seropositivity increased to 71.7% in the 40–45 age group. No large differences were noted by area of residence, educational level or SES.

4. Discussion

This study found a VZV seroprevalence of 54.2% in Colombo district in Sri Lanka. Children below 1 year of age were seronegative, and only about 10% of children between 1–10 years of age were seropositive. Thereafter, the seropositive status rose steeply and by the age of 40 years, about 75% were seropositive. Males and subjects with less than primary education had a relatively low seropositivity. There were no significant differences in seroprevalence by urban/rural residence or SES. Among women of childbearing age, the overall seroprevalence was 62.0% but was low (37.0%) in the 15–19 age group.

Seroprevalence of VZV varies geographically and climatically across countries. Other tropical countries in the Southeast Asian countries reported similar VZV seroprevalence as found in this study, Thailand (52.8%)[17], Pakistan (41.8%)[18] and Singapore (55.3%)[19]. India reported a slightly higher seroprevalence (68.2%)[20]. In contrast, countries with temperate climates reported

Table 2
Seropositivity according to selected sociodemographic characteristics and age groups (%).

Characteristics	Age groups							
	Total (*n*=1 258)	< 1 year (*n*=4)	1–4 years (*n*=92)	5–9 years (*n*=97)	10–19 years (*n*=206)	20–39 years (*n*=434)	40–59 years (*n*=307)	60 years (*n*=118)
Total	54.2	0.0	9.7	10.3	34.5	63.1	74.3	76.3
Gender								
Male	43.2	0.0	9.7	18.4	35.5	59.7	71.4	72.7
Female	58.8	0.0	9.8	2.1	33.3	63.9	74.9	77.6
Residence								
Urban	53.6	0.0	10.7	11.5	33.9	64.2	70.8	77.9
Rural	55.1	0.0	8.3	8.3	35.4	61.5	79.5	74.0
Education								
Lower than primary	25.6	0.0	7.7	9.5	18.1	83.3	76.5	73.1
Secondary/pre-university	61.9	0.0	100.0	50.0	35.1	63.4	74.3	75.9
Diploma/degree	61.8	0.0	0.0	0.0	100.0	54.2	50.0	100.0
Social economic status								
Low	56.2	0.0	11.4	10.8	37.4	65.8	74.9	77.9
Medium	49.6	0.0	3.4	8.7	29.3	56.8	74.0	65.0
High	55.1	0.0	100.0	11.1	22.2	63.8	74.0	100.0

Table 3

Seropositivity of women of childbearing age according to selected sociodemographic characteristics and age groups (%).

Characteristics	Age group						
	Total (n=503)	15–19 years (n=62)	20–24 years (n=94)	25–29 years (n=95)	30–34 years (n=51)	35–39 years (n=87)	40–45 years (n=85)
Total	62.0	37.0	60.6	67.3	63.7	64.3	71.7
Residence							
Urban	61.9	37.8	61.2	61.6	68.0	64.1	72.5
Rural	62.1	36.0	59.3	77.1	57.5	64.7	70.5
Education							
Lower than primary	75.0	0.0	100.0	0.0	100.0	100.0	71.0
Secondary/ pre university	62.3	36.6	64.3	67.8	63.6	63.0	71.7
Diploma/degree	44.4	100.0	0.0	75.0	50.0	100.0	0.0
Social economic status							
Low	64.1	41.6	66.6	77.3	65.0	60.8	70.3
Medium	57.1	20.0	50.0	51.4	65.6	66.6	68.1
High	64.4	25.0	33.3	71.4	50.0	71.4	88.8

a much higher VZV seroprevalence, United States (97.8%)[21], Italy (93.0%)[22], Spain (90.2%)[23], Canada (88.9%)[24], *etc*. Effects of climate, competition with other viruses and level of social interactions have been suggested as potential reasons for these differences between tropical and temperate climates, but none have been substantiated[25].

The age-specific seroprevalence patterns reported in this study is similar to that reported by Thailand, Singapore and Pakistan. Overall, the seroprevalence increased with age and plateaued at 60 years. For example, in Thailand, age-specific seroprevalence increased with age; it was 15.5% in 9 months–4 years age group and increased to 75.9% in the 20–29 age group[17]. Children less than 1 year were naive to varicella in present study. Similar findings were reported in Canada where 96.4% of newly migrant children below 1 year of age had no detectable VZV antibodies[26].

A statistical significant difference in seroprevalence between males (43.2%) and females (58.8%) was noted in this study. This difference is not consistent; for females, a dip is noted in the 5–9 age group and two peaks at the 20–39 and 40–59 age-groups. The overall finding of lower seroprevalence in males is consistent with other studies that also reported a lower seroprevalence in males compared to females: Thailand (males, 49.5%; females, 55.2%)[17]; Pakistan (males, 39.6%; females, 45.2%)[18] and Singapore (males, 67.9%; females, 73.0%)[19].

Subjects with less than primary education had low seropositivity reflecting the low seropositivity associated with the < 9 year age group. Of the 266 subjects with less than primary education, 189 (71.0%) were less than < 9 years of age.

This study found that 62.0% of women of childbearing ages are not protected against VZV infection, doubling to 37.0% among teenage women. A high seroprevalence among child bearing age group women has been reported in industrialized countries and some Asian countries. Pregnant women in temperate countries have shown high seropositivity, 98.0% in France[27], 97.0% in Eastern Germany[28], 96.2% in South Western Finland[29], 96.0% in Spain[30], 92.1% in Canada[24], and 80.9% in Italy[22]. Some Asian countries reported a higher seroprevalence among women of childbearing age than that found in this study; over 90.0% in South Korea[31], 71.0% in Singapore[19], 75.9% in Thailand[17] and 88.1%–91.1% in India[20]. VZV infection in pregnancy causes intrauterine growth retardation in 23% and low birth weight in almost all babies. The highest rate of mortality and morbidity occur in the presence of congenital varicella syndrome, maternal varicella pneumonia and neonatal varicella[32,33]. VZV infection occurring in the first 20 weeks of gestation, particularly between 8–20 weeks of gestation, is associated with a risk of congenital varicella syndrome (about 12% in infected fetuses)[34], characterized by skin lesions, hypoplasia of limbs, encephalitis, microcephaly, ocular abnormalities and mental retardation; mortality is about 30%. Maternal pneumonia complicates 10%–20% of varicella infection in pregnancy. The risk increases with increasing gestational age; about 40% of these women require mechanical ventilator support due to the pressure of the gravid uterus on the diaphragm; mortality is 3%–14%. Maternal VZV infection occurring 5 d prior to delivery to 48 h postpartum may result in 50% of neonates being infected, and about 25% presenting with clinical varicella; mortality may be as high as 30%[32-34].

Varicella vaccine is available as a monovalent varicella only or in combination with measles, mumps and rubella vaccine for healthy children > 2 months, adolescents and adults[35] for prevention. The WHO recommends: a single dose of vaccine to children less than 13 years (seroconversion was noted in about 95% of healthy children following one dose of vaccination)[6]; and two doses of vaccine in adolescents and adults 4–8 weeks apart[6]. In most developing countries, varicella is not high in the priority list of vaccine preventable disease as other vaccine preventable disease cause greater morbidity and mortality than varicella. Countries need to consider several factors before including varicella vaccine in national immunization programs such as control of other more serious infectious diseases, cost, age of vaccination, coverage (85%-90%) and storage (-15 ℃)[6].

In Sri Lanka, with the commencement of the Expanded Programme on Immunization in 1978, the country's focus strengthened to eliminate childhood vaccine preventable diseases. The national immunization program has continued to make excellent progress over the past three decades, most notably in terms of achieving high immunization coverage 90% and disease control[12,36].

Although varicella vaccine is not included in the national immunization program, it is available in private hospitals/clinics since 2004. Therefore, only subgroups of the population who access these services are likely to avail of the varicella vaccine. Sri Lanka has an excellent primary health care system in South Asia. The government's health expenditure as a percent of total government expenditure is 5.96[9]. The country has established the feasibility of high coverage of its national immunization programs and control of other serious vaccine preventable diseases. Varicella is a notifiable disease since 2005[11]. The epidemiological pattern of varicella in the country may be changing due to partial vaccination coverage, with increasing cases in adolescents and adults, groups that are at high risk for severe

disease[6]. The impact on the healthcare system is high. Further, the low seropositivity in younger women of childbearing age is of concern. In view of these considerations, the justification of including varicella vaccine in the national immunization program is compelling.

Conflict of interest statement

The authors declare they have no conflict of interest.

References

[1] Steain M, Slobedman B, Abendroth A. The host immune responses to varicella zoster virus. *Future Virol* 2012; **17**(12): 1205-1220.

[2] Centers for Disease Control and Prevention. *Epidemiology and prevention of vaccine-preventable diseases*. 13th ed. Washington D.C.: Public Health Foundation; 2015.

[3] Hambleton S, Gershon AA. Preventing varicella-zoster disease. *Clin Microbiol Rev* 2005; **18**(1): 70-80.

[4] Mandell, Doughlas, Bennett's. *Principles and practice of infectious diseases*. 7th ed. Philadelphia: Churchill Livingstone Elsevier; 2010.

[5] Lozano R, Naghavi M, Foreman K, Zheng Z, Lopez AD, Murray CJL, et al. Global and regional mortality from 235 causes of deaths for 20 age groups in 1990 and 2010: A systematic analysis for the global burden of disease study 2010. *Lancet* 2012; **350**(9895): 2095-2128.

[6] World Health Organization. Immunization, vaccines and biological 2008; 8th July. [Online]. Available from: http: //www.wh.int/section medicines/en/. Accessed on May 1, 2017.

[7] Brisson M, Racine E, Drolet M. The potential impact of varicella vaccination in low to middle income countries: A feasibility modeling study. Report to the SAGE working group on varicella and herpes zoster vaccines. 1-23. [Online]. Available from: http: //www.who.int/immunization/sage/meetings/2014/april/5_The_potential_impact_Varicella_vaccination_Low_Middle_Income_Countries_feasibility_modeling.pdf. Accessed on May 2017.

[8] Department of census and statistics, Ministry of National policies and Economic affairs, Sri Lanka. Census of population and housing, Colombo District report 2011. [Online]. Available from: http: //www.statistics.gov.lk/PopHouSat/CPH2011/index.php?fileName=FinalReportE&gp=Activities&tpl=3. Accessed on May 2017.

[9] Medical Statistic Unit, Ministry of Health. *Ann health bull*. Sri Lanka: Medical Statistics Units, Ministry of Health; 2014.

[10] Welgama U, Wickramasingha C, Perera J. Varicella Zoster virus infection in the Infectious Disease Hospital, Sri Lanka. *CMJ* 2004; **48**(4): 119-121.

[11] Epidemiology Unit, Ministry of Health. *Surveillance case definitions for notifiable diseases in Sri Lanka*. 2nd ed. Sri Lanka: Epidemiology Unit, Ministry of Health; 2011.

[12] Epidemiology Unit, Ministry of Health. *Immunization hand book*. 3rd ed. Sri Lanka: Epidemiology Unit, Ministry of Health; 2012.

[13] Liyanage NP, Fernando S, Malavige GN, Mallikahewa R, Sivayogan S, Jiffry MT, et al. Seroprevalence of Varicella Zoster virus infections in Colombo district, Sri Lanka. BMC Infectious Diseases. *Indian J Med Sci* 2007; **61**(3): 128-134.

[14] Kurukulasooriya GM, Thevanesam V, Agampodi SB, Abeykoon AM, Amarasiri SP, Goonasekara KP. Susceptibility of new entrant university students in Sri Lanka to varicella zoster infection. *Asia Pac J Public Health* 2010; **22**(2): 219-224.

[15] Noordeen F, Dissanayake R, Weerasekara IKB, Kumarasiri PVR, Wijedasa MH. Risk factors for acquiring varicella zoster virus (VZV) infection and sero-prevalence of anti VZV immunoglobulin. G antibodies in adolescent from a tropical population. *Sri Lankan J Infect Dis* 2014; **4**(1): 30-37.

[16] Diagnostic Automation, Inc. Varicella IgG. [Online]. Available from: http: //www.rapidtest.com/Varicella%20IgG_1412Z-web.pdf. Accessed on May 2017.

[17] Lolekha S, Tanthiphabha W, Sornchai P, Kosuwan P, Sutra S, Warachit B, et al. Effect of climatic factors and population density on varicella zoster virus epidemiology within a tropical country. Am *J Trop Med Hyg* 2001; **64**(3-4): 131-136.

[18] Akram DS, Qureshi H, Mahaumd A, Khan AA, Kundi Z, Shafi S. Seroepidemiology of varicella zoster in Pakistan. *SE Asian J Trop Med* 2001; **31**(4): 646-649.

[19] Fatha N, Ang LW, Goh KT. Changing seroprevalence of varicella zoster virus infection in a tropical city state, Singapore. *Int J Infect Dis* 2014; **31**(22): 73-77.

[20] Lokeshwar MR, Agrawal ASD, Subbarao MS, Chakraborty AV, Ram Prasad JW, Bock HL, et al. Age related seroprevalence of antibodies to varicella in India. *Indian Pediatr* 2000; **37**(7): 714-719.

[21] Lebo EJ, Kruszon-Moran DM, Marin M, Bellini WJ, Schmid S, Bialek SR, et al. Seroprevalence of measles, mumps, rubella and varicella antibodies in the United States population, 2009–2010. *Open Forum Infect Dis* 2015; **2**(1): ofv006.

[22] Tafuri S, Gallone MS, Cappelli MG, Gallone MF, Larocca AMV, Germinario C. A seroprevalence survey on varicella among adults in the vaccination era in Apulia (Italy). *Vaccine* 2014; **32**(48): 6544-6547.

[23] Perez-Farinos N, Garcia-Comas L, Ramirez-Fernandez R, Ordobas M. Seroprevalence of antibodies to varicella zoster virus in Madrid (Spain) in the absence of vaccination. *Cent Eur J Public Health* 2008; **16**(1): 41-44.

[24] Ratnam S. Varicella susceptibility in a Canadian population. *Can J Infect Dis* 2000; **11**(5): 249-253.

[25] World Health Organization. Varicella and herpes zoster vaccine: WHO position paper, June 2014-Recommendations. *Vaccine* 2016; **34**(2): 198-199.

[26] Greenaway C, Boivin JE, Cnossen S, Ross C, Tapiero B, Schwartzman K, et al. Risk factors for susceptibility to varicella in newly arrived adult migrants in Canada. *Epidemiol Infect* 2014; **142**(8): 1695-1707.

[27] Saadatian-Elahi M, Mekki Y, Del Signore C, Lina B, Derrough T, Caulin E, et al. Seroprevalence of varicella antibodies among pregnant women in Lyon – France. *Eur J Epidemiol* 2007; **22**(6): 405-409.

[28] Sauerbrei A, Prager J, Bischoff A, Wutzler P. Antibodies against vaccine-preventable disease in pregnant women and their offspring. Measles, mumps, rubella, poliomyelitis, and varicella. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2004; **47**(1): 10-15.

[29] Alanen A, Kahala K, Vahlberg T, Koskela P, Vainionpa R. Seroprevalence, incidence prenatal infections and reliability of maternal history of varicella zoster virus, cytomegalovirus, herpes simplex virus and parvovirus B19 infection in South Western Finland. *BJOG: Int J Gynecol Obstet* 2005; **112**(1): 50-56.

[30] Plans P, Costa J, Espuñes J, Plasència A, Salleras L. Prevalence of varicella-zoster antibodies in pregnant women in Catalonia (Spain). Rationale for varicella vaccination of women of child bearing age. *BJOG: Int J Gynecol Obstet* 2007; **114**(9): 1122-1127.

[31] Choi WS, Noh JY, Huh, JY, Jo YM, Lee J, Song JY, et al. Seroprevalence of varicella-zoster virus in Korea. *J Med Virol* 2010; **82**(12): 2123-2126.

[32] Katz VL, Kuller JA, Mcmahon MJ, Warren MA, Well SR. Varicella during pregnancy, maternal and fetal affects. *West J Med*. 1995; **163**(5): 446-450.

[33] Paul Tan M, Koren G. Chickenpox in pregnancy: Revisited. *Reprod Toxicol* 2006; **21**(4): 410-420.

[34] Lamont RF, Sobel JD, Carrington D, Tovi SM, Kusanovic JP, Vaisbuch E, et al. Varicella–zoster virus (chickenpox) infection in pregnancy. *BJOG: Int J Gynaecol Obstet* 2011; **118**(10): 1155-1162.

[35] Centers for Disease Control and prevention. Prevention of varicella: Recommendation of the Advisory Committee on Immunization Practices (ACIP). *MMWR Morb Mortal Wkly Rep* 2007; **56**(RR04): 1-40.

[36] Peiris TSR. National immunization programme of Sri Lanka and key principles in immunization. [Online]. Available from: http: //www.epid.gov.lk/web/attachments/article/137/EPI_Programme_in_Sri_Lanka.doc. Accessed on May 2017.