Available online at *www.ujpronline.com*
Universal Journal of Pharmaceutical Research
An International Peer Reviewed Journal
ISSN: 2831-5235 (Print); 2456-8058 (Electronic)

RESEARCH ARTICLE

PREVALENCE OF RUBELLA IGG ANTIBODIES AMONG PRODUCTIVE-AGE WOMEN IN AL-MAHWEET GOVERNORATE, YEMEN

Amatalkhaliq Abdullah Gobara'a[1], Wadhah Hassan Edrees[2*], Wadee Abdullah Al-Shehari[3], Anwar Al-Madhagi[1], Khaled Al-Moyed[1], Maged Mohammed Almezgagi[1], Alariqi Reem[1]

[1]*Medical Laboratory Department, Faculty of Medical Sciences, Sana'a University, Yemen.*
[2]*Medical Laboratory Department, Faculty of Medical Sciences, Al-Razi University, Yemen.*
[3]*Department of Microbiology, Faculty of Medical Sciences, Ibb University, Yemen.*

Article Info:

Article History:
Received: 1 June 2020
Reviewed: 9 July 2020
Accepted: 20 August 2020
Published: 15 September 2020

Cite this article:
Gobara'a AA, Edrees WH, Al-Shehari WA, Al-Madhagi A, Al-Moyed K, Almezgagi MM, Reem A. Prevalence of rubella igg antibodies among productive-age women in Al-Mahweet Governorate, Yemen. Universal Journal of Pharmaceutical Research 2020; 5(4):28-32.
https://doi.org/10.22270/ujpr.v5i4.436

***Address for Correspondence:**
Dr. Wadhah Hassan Edrees, Medical Laboratory Department, Faculty of Medical Sciences, Al-Razi University, Yemen, Tel: +967-771673230.
E-mail: *edress2020@gmail.com*

Abstract

Background: Rubella is an infectious viral disease that caused by the *Rubella* virus. The incidence of rubella infection in women during pregnancy leads to complications for fetus development and cause congenital rubella syndrome or fetal death. This study aimed to determine the prevalence rate of rubella among reproductive-age women in Al-Mahweet, Yemen.
Methods: A cross sectional study was conducted among females attending healthcare centers and schools from July 2007 to June 2008. Blood samples were collected individually from 270 females aged 15-35 years and the rubella virus IgG antibody was quantitated by enzyme-linked immunosorbent assay (ELISA). The needed data were collected by using a pretested questionnaire and analyzed by statistical program.
Results: Overall, 197(73%) had IgG-positive antibody to rubella and 73(27%) had IgG-negative antibody to rubella. The highest rate of anti-rubella IgG was among females aged 15-25 years and the lowest was among the females aged 31-35 years. Similarly, the higher rate was among females living in urban area compared to females from rural area. The statistically significant difference was found between most educational levels and positive results of anti-rubella IgG. With regard to marital status, the most frequent of rubella antibody was 72.3%, 73.1%, and 75.0%, respectively, recorded among single, married, and divorced females. The non-pregnant women had (73.7%) more incidence to rubella IgG antibody than pregnant (66.7%). 82.2% of IgG- positive women had no history of stillbirth and 65% had a history of stillbirth.
Conclusions: Most of the enrolled females had immunity against rubella virus, but still significant percentages were susceptible to rubella infection. Thus, it is essential to introduce of rubella vaccine to control and prevent the rubella virus circulating among the community.
Keywords: Al-Mahweet, antibody, IgG, prevalence, rubella virus, women, Yemen.

INTRODUCTION

Rubella or German measles is a worldwide infection that caused by the Rubella virus. It is a member of Togaviridae family that is enveloped, icosahedral viruses, contain a positive-sense, single-stranded RNA genome[1]. Humans are considered the only reservoir for the Rubella virus transmitted by airborne droplets from infected individuals during sneeze or cough. Both children and adults are susceptible to rubella infection that has an incubation period of 2–3 weeks[2]. In children, the rubella is usually harmlessly characterized by only slightly lymphadenopathy and a mild flat rash with pink to red spots that persistent for three days. Whereas in adults it causes a severe infection that may lead to arthritis or encephalitis[3,4]. The infected pregnant women by the Rubella virus during the first trimester of gestation can lead to spontaneous abortions, stillbirths, and congenital rubella syndrome (CRS). CRS causes defects in heart, blindness, deafness, and intellectual disability[5,6]. Globally, approximately 100 thousand of children are annually born with CRS[7]. There are no specific drugs that exist to treatment rubella infection and prevent transmission to the fetus. So, it is important that girls obtain immunity to rubella infection before reproduction age to avoid such serious consequences[8]. Rubella occurs an epidemics in different countries that are not implemented the routine

immunization Programs. The prevalence of rubella antibody was 92% recorded among females aged between 15 and 49 years in Jeddah, Saudi Arabia[9] and 94.6% among pregnant women in Kerman city, Iran[10]. Also, the prevalence of >90% of rubella antibodies among pregnant women and the general population has been reported in several African countries[11,12]. In Yemen, many reports documented the pathogenic viruses prevalence among the population but there are few reports that investigated the prevalence of rubella antibodies[13]. In Sana'a city, Sallam *et al.*,[14] revealed that 91.64% of schoolgirls aged 11-21 were positive for IgG rubella antibodies. Also, the prevalence rate of rubella antibodies was 85.4% among schoolchildren in Sana'a governorate[8]. Recently, Al-Qadasi *et al.*,[15] found that 3.7% of pregnant women were positive for rubella IgM antibody. Until now, the previous studies on the frequency of rubella antibodies focused only in Sana'a and there are no data about the rubella antibodies state in another governorate of Yemen such as Al-Mahweet. Therefore, this cross-sectional study aimed to determine the prevalence rate of rubella among reproductive-age women in Al-Mahweet governorate, Yemen.

SUBJECTS AND METHODS

Study Design and Population

This cross sectional study was conducted in the Maternal and Child center at Al-Gomhory hospital and two secondary schools namely Al- Khansa'a and Aisha, from July 2007 to June 2008, that located in Al-Mahweet governorate. Ethical approval for this study was obtained from the ethical committee of the Faculty of Medical Sciences of Sana'a University. The aims of this study are explained in brief to each participated female and gave consent.

Data Collection

A structured and pre-tested questionnaire was approved by the Faculty of Medical Sciences of Sana'a University. The questionnaire was structured to included socio-demographic information (age, marital status, residence, educational level, occupational status), pregnancy status, and history of clinical information. The participants interviewed face to face and questionnaire filled by the researcher.

Specimens Collection and Examination

Five mL of blood samples were collected from each participated woman by venous puncture and serum separated by centrifuge. The obtained sera stored at –20°C until the serological analysis was performed. The anti-Rubella virus IgG antibodies were quantified by enzyme-linked immunosorbent assay (ELISA) (Equipar SRL, Italy). The concentration of IgG ant-rubella in serum sample ≥20 IU/ml were considered positive.

Statistical Analysis

The obtained results were analyzed by SPSS version 18 (SPSS Inc., USA). The relative risk (RR >1), 95% confidence interval (CI), Chi-square test (χ^2), and value of probability $p<0.05$ (significant) were used to examine the significance of the relations between the prevalence of rubella IgG antibody and potential risk factors.

RESULTS

A total of 270 females aged 15-35 years (mean age 21.9 years) attending healthcare and schools were enrolled in the study. The present findings revealed that the overall prevalence rate of rubella IgG antibody was 197(73%) positive recorded among females. Whereas 73(27%) of participants were negative for rubella IgG antibody (Figure 1). The current results according to age found that the highest prevalence of rubella IgG antibody frequency was reported among age-group 15-25 years and the lowest frequency rate was found among the age group 31-35 years. Also, there were no statistically significant differences between rubella IgG antibody prevalence and age group listed in Table (1).

The females coming from the urban area had the highest rate (75.2%) of the rubella IgG antibody when compared to females coming from the rural area and there were no statistically significant. The result regarding occupation showed that the higher rate of rubella IgG antibody was recorded among employee females (74.5%) followed by a student (72.5%), and house-wife (71.6%), and there also were no statistically significant (Table 1). The current work according to the educational level, it was found that the most frequent of rubella IgG antibody was recorded among the secondary level (92%) followed by the illiterate (90.9%), university (66.2%), elementary (50%), and primary level with 38.1%.

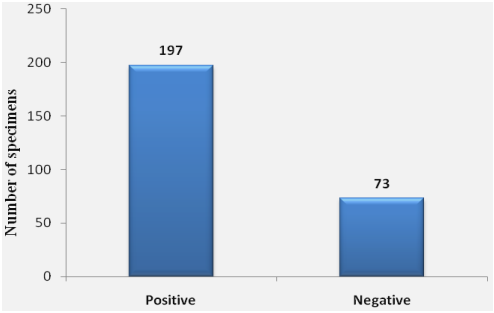

Figure 1: The distribution of rubella IgG antibody result.

The results of elementary, secondary, primary and finally illiterate in terms of rubella IgG positivity were highly statistically significant with values of χ^2 =30.65, p=0.000001; χ^2 = 29.18, p=0.000001; χ^2 =7.04, p=0.007 and finally χ^2 =6.14, p=0.01 respectively, (Table 1). The result based on marital status showed that the nearly similar positive results were noticed among single, married, and divorced females with percentages of 72.3%, 73.1%, and 75.0%, respectively. In contrast, the two of the participated widow females showed completely positive for the anti-rubella IgG antibody (Table 1). In the result according to the pregnancy, the higher prevalence of rubella IgG antibody was (73.7%) reported among non-pregnant women, while the lower was (66.7%) (Table 2).

Table 1: Prevalence of rubella IgG antibody in relation to socio-demographic characteristics.

Illustrative variables		No. examined (%)	No. of positive IgG (%)	*RR*	*CI*	χ^2	*P*
Age in years	15-20	101 (37.4)	75 (74.3)	1.03	0.9-1.2	0.14	0.71
	21-25	71(26.3)	53(74.6)	1.12	0.6-2.2	0.14	0.70
	26-30	72(26.7)	51(70.8)	0.96	0.8-1.14	0.23	0.63
	31-35	26(9.6)	18(69.2)	0.94	0.7-1.23	0.22	0.65
Residence	Urban	145(53.7)	109(75.2)	1.07	0.92-1.24	0.78	0.78
	Rural	125(46.3)	88(70.4)	0.94	0.8-1.09	0.78	0.37
Occupation	Employee	98(36.3)	73(74.5)	1.13	0.6-2.06	0.18	0.66
	Student	98(36.3)	71(72.5)	0.99	0.85-1.15	0.02	0.88
	House-wife	74(27.4)	53(71.6)	0.98	0.8-1.2	0.06	0.8
Education level	Illiterate	33(12.2)	30(90.9)	1.29	1.13-1.48	6.14	0.01
	Primary	24(8.9)	12(50)	0.66	0.44-1.0	7.04	0.007
	Elementary	42(15.6)	16(38.1)	0.48	0.32-0.71	30.60	0.000001
	Secondary	100(37)	92(92)	1.49	1.3-1.7	29.18	0.000001
	University	71(26.3)	47(66.2)	0.88	0.37-1.06	2.24	0.13
Marital state	Single	130(48.15)	94(72.3)	0.98	0.85-1.14	0.05	0.081
	Married	130(48.15)	95(73.1)	1.0	0.87-1.16	0.00	0.96
	Divorced	8(2.96)	6(75)	1.03	0.68-1.55	0.02	0.96
	Widow	2(0.74)	2(100)	1.37	1.28-1.48	0.75	0.38

RR= Relative risk >1 (at risk); CI= Confidence intervals; χ^2=Chi-square ≥3.84; p<0.01 (significant)

However, out of 130 married females, the rubella IgG antibody was more prevalent among women who had no history of stillbirth with 82.2% whereas 65% of women who had a history of stillbirth showed positive for rubella IgG antibody and there is no statistically significant difference (Table 2). Out of the 197 positive studied females, 25 (73.5%) of females had a family history for rubella and the rest 172(72.9%) of positive females had no family history for rubella and there were also no statistically significant (Table 2).

Table 2: Prevalence of rubella IgG antibody in relation to pregnancy statue and history of clinical information.

Illustrative variables		No. examined (%)	No. of positive IgG (%)	*RR*	*CI*	χ^2	*P*
Pregnancy statue	Pregnant	30(23)	20(66.7)	0.98	0.86-1.16	0.84	0.04
	Non- pregnant	100(77)	73(73)	1.0	0.7-1.1	0.99	0.06
Stillbirth state	Yes	40(30.8)	26(65)	0.87	0.86-1.16	1.51	0.21
	No	90(69.2)	74(82.2)	1.07	0.93-1.24	0.85	0.35
Family history for rubella	Yes	34(12.6)	25(73.5)	1.01	0.81-125	0.01	0.93
	No	236(87.4)	172(72.9)	0.99	0.8-1.23	0.01	0.93

RR Relative risk >1 (at risk); CI Confidence intervals; χ^2Chi-square ≥3.84; p<0.01 (significant)

DISCUSSION

Rubella has a worldwide distribution with the infection being endemic in all countries that had not a highly successful infant immunization policy or no immunization policy at all. An outbreak of rubella usually occurs in winter, spring, and early summer and spreads very easily through airborne droplets within the community[16]. The current study revealed that 73% of studied females were showed positive for rubella IgG antibody while 27% of females were negative. These findings are lower than the rates recorded from several studies among women where the prevalence rates of rubella IgG antibody was reported as 91.64% in Sana'a city[14], 89.5% in Poland[17], 85.4% in Sana'a governorate[8], 94.4% in Turkey[18], 92% in Saudi Arabia[9], and 94.6% in Iran[10]. However, the lower rate of this study was reported by Olajide *et al.*,[19] in Nigeria, revealing that anti-rubella IgG was 38.8% among pregnant and non-pregnant women. Despite the fact that vaccination against rubella in Yemen is not implemented as a routine program of immunization, the present data showed that most studied females had antibodies to rubella virus, suggesting a previous exposure rather than vaccination. Consequently, the presence of IgG antibody is a sero-marker of immunity against rubella virus[20,21]. Also, the absence IgG antibody indicates susceptibility to acquiring rubella infection particularly unimmunized women during the pregnancy statue and transmit it vertically to her fetus. The incidence of rubella infection through the first trimester or second trimester represents a risk for the developing fetus resulting in congenital rubella syndrome[5,6]. The antibody prevalence ranged between 69.2% and 74.3% for the different age groups. The relatively low prevalence in the older age group (31-35 years) may indicate an age association, therefore a possible clearly age association could be determined by an additional future study that includes females ranging

between <15 and >35 years of age. Also, the statistical analysis showed there no significant statistical difference between the age groups and the IgG positive results. Previous reports revealed that the high rate of rubella IgG antibody was recorded among the age group of 5-8 years in Sana'a, Yemen[8], 15-19 years in Jeddah, Saudi Arabia[9], 26-30 years in Egypt[22], 26-35 years in Mosul City, Iraq[23]. The vibration on the increase in different age groups doesn't seem to represent a risk factor. The seroprevalence rate for the rubella antibody in this study showed an increased rate among women coming from the urban area, but no statistical differences were reported between the resident group and the prevalence of anti-rubella IgG. Similarly, a higher rate of IgG anti-rubella prevalent was recorded among females residing in the urban area in Mosul city, Iraq[23]. Also, it was found that the high rate was recorded among assayed women for rubella IgG antibody living in urban area in Ethiopia[24]. Conversely, a study by Sallam *et al*.,[8] observed that the participants from the rural area had a higher prevalence rate of rubella IgG antibody than the urban area. Also, Gadallah *et al*.,[22] noticed that the participants belong to a rural area having a high rate than participated women coming from an urban area. Olajide *et al*.,[19] found that the prevalence rate of rubella IgG was 93.8% and 90.3% in urban and rural areas, respectively. In the urban area, the high density of the population might increase the transmission rate and females who do not have protective levels of rubella resistance might get the infections. In the current result according to the occupation, it was observed that the high rate of rubella IgG antibody prevalence was recorded among employed females followed by the student, and house-wife, and there were no statistically significant differences. In a similar investigation by Olajide *et al*.,[19] reported that the prevalence rate of rubella IgG was 93.2%,93.4%, and 92.5%, respectively, among students, workers, and housewives. Also, Wondimeneh *et al*.,[24] revealed that most frequent rubella IgG antibody was recorded among student (88.9%), farmer (88.6%), merchant (88.1%), civil servant (77.8%), housewife (77.3%), and daily laborer (74%). In this work, the seroprevalence of anti-rubella IgG antibody in association with the educational level showed that the highest positive results were most frequently reported at the secondary level. Also, the statistical analysis results showed the highly significant (p<0.05) differences between anti-rubella IgG prevalence and most of the educational level except individuals having a university degree. These findings are in agreement with Wang *et al*.,[24,25] in Taiwan, that revealed that there was a statistically significant association between the low educational level and seronegativity to rubella. A similar study by Wondimeneh *et al*.,[24] observed that no formal education participants had a slightly high rate of anti-rubella IgG. In Iraq, Al-Mukhtar *et al*.,[23] recorded that the higher prevalence was among individuals with the education of diploma or college and illiterate while the lower rate was among the high school individual. Also, Olajide *et al*.,[19] registered the illiterate and primary school females showing completely (100%) IgG-positive while the secondary and tertiary ranging from 90% to 93.2%. Conversely, Gadallah *et al*.,[22] illustrated the university grade and primary to secondary school individuals show nearly similar anti-rubella prevalence and no significant differences. The variation in previous results to this result may be referred to as many factors that play a minor role in rubella virus infection. These factors including frequency of exposure, diagnosis methods, the social variations such as the behavior of the population, environmental hygiene, and cultural variances related to feeding habits, levels of the educational, and primary healthcare program. In the present result, the single, married, and divorced females showed nearly similar results for anti-rubella IgG that ranged between 72.3% to 75%. The two of the participants who were widows showed comparatively positive for the anti-rubella IgG antibody. This finding is in agreement with Gadallah *et al*.,[22] who observed that the prevalence rate of anti-rubella IgG was 84.6% and 80.3%, respectively, among married and single women. In contrast, Wondimeneh *et al*.,[24] noticed that the highest rate was among married and lowest among single and divorced women. Also, it was found the rubella IgG antibody among unmarried women were more than in married women[23]. In fact, all women are exposed to rubella infection and the high potential risks present during pregnancy period. In the current work, out of the 130 married females, it was reported that the highest prevalence of anti-rubella IgG were (73.7%) among non-pregnant women and the lowest was 66.7% among pregnant women. In a similar study conducted in Poland, it was found that up to 90% of healthy pregnant females were positive for rubella antibody[17]. In Nigeria, Olajide *et al*.,[19] observed that anti-rubella IgG prevalence was 93.75% among pregnant women and 90% among non-pregnant women. Also, in a study conducted in Iran among pregnant women that 15% of them were positive for rubella antibody[26]. The current result according to the history of stillbirth, it was found that 82.2% of IgG-positive study participants with no one had history of stillbirth were positive, whereas 65% of IgG-positive women had a history of stillbirth. In a similar study, Olajide *et al*.,[19] showed that 92.5% of females with no history of stillbirth were IgG-positive for rubella and 100% of IgG-positive females had a history of one to four stillbirth. Also, Wondimeneh *et al*.,[24] reported that 79.2% of IgG-positive without a history of stillbirth, and 82.4% of IgG-positive females had a history of one to three stillbirth. However, the result in this study revealed that 73.5% of females IgG-positive had a family history for rubella infection and 72.9% of IgG-positive females had no family history for rubella infection. It is noticed from this result that, there were no statistically significant differences between the families with history for rubella and the families without rubella, indicating that previous history for rubella does not influence the prevalence of infection.

CONCLUSIONS

The high prevalence of rubella IgG antibody among enrolled females indicates that they had immunity against rubella virus. But, there are about a quarter of

assayed females remain susceptible to rubella virus infection and cause the complications antenatal during development resulting in congenital rubella syndrome (CRS). Therefore, all females should be vaccinated early for reducing the risk of rubella virus infection during pregnancy stage and CRS in infants.

ACKNOWLEDGEMENTS

The author forwards special thanks to the Health and Education Offices of the governorate of Al-Mahweet for their invaluable help and coordination.

AUTHOR'S CONTRIBUTION

Gobara'a AA: writing original draft, methodology. **Edrees WH:** investigation, conceptualization. **Al-Shehari WA:** formal analysis, conceptualization. **Al-Madhagi A:** editing, methodology. **Al-Moyed K:** investigation, supervision. **Almezgagi MM:** data curation, conceptualization. **Reem A:** data interpretation. All authors revised the article and approved the final version.

DATA AVAILABILITY

Data will be made available on reasonable request.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

REFERENCES

1. Bauman WR, Cosby DC, Fulks J, Lammert MJ. Microbiology with diseases by body system. 4th ed 2009 Pearson Education, New York, US. 2019; 582-583.
2. Mounerou S, Maléwé K, Anoumou DY, Sami N, Koffi A, Mireille P. Seroprevalence of rubella IgG antibody among pregnant women attending antenatal clinic in Lomé, Togo. Am J Infect Dis Microbiol 2015; 3(4):134–136. *https://doi.org/10.12691/ajidm-3-4-3*
3. Al-Rubai B, Aboud M, Hamza W. Evaluation of anti-rubella antibodies among childbearing age women in Babylon Governorate. Med J Babylon 2010; 7:2-7.
4. Lezan MM. Prevalence of rubella virus in pregnant women in Kirkuk City-Iraq. Kirkut Univ J Sci Stud 2015; 10(1):47–57.
5. Centers for Disease Control and Prevention (CDC). Elimination of rubella and congenital rubella syndrome-United States, 1969-2004. MMWR Morb Mortal Wkly Rep 2005; 54(11):279-282. *PMID: 15788995*
6. World Health Organization (WHO). Status report on progress towards measles and rubella elimination SAGE working group on measles and rubella (22 October 2012) 2012.
7. World Health Organization (WHO). Global measles and rubella: Strategic plan 2012-2020.
8. Sallam TA, Al-Jaufy AY, Al-Shaibany KS, Bin Ghauth A, Best JM. Prevalence of antibodies to measles and rubella in Sana'a, Yemen. Vaccine 2006; 24: 6304–6308. *https://doi.org/10.1016/j.vaccine.2006.05.083*
9. Alsibiani AS. Rubella immunity among pregnant women in Jeddah, Western region of Saudi Arabia. Obstetrics Gynecol Int 2014. *https://doi.org/10.1155/2014/659838*
10. Ganjooie TA, Mohammadi MM. The prevalence of antibodies against rubella in pregnant women in Kerman, Iran. Saudi Med J 2003; 24:1270–1271. *PMID: 14647572*
11. Lawn JE, Reef S, Baffoe-Bonnie B, *et al*. Unseen blindness, unheard deafness, and unrecorded death and disability: Congenital rubella in Kumasi, Ghana. Am J Public Health 2000; 90: 1555–15561. *https://doi.org/10.2105/ajph.90.10.1555*
12. Cutts FT, Abebe A, Messele T, *et al*. Sero-epidemiology of rubella in the urban population of Addis Ababa, Ethiopia. Epidemiol Infect 2000; 124: 467–479. *https://doi.org/10.1017/s0950268899003532*
13. Almezgagi MM, Edrees WH, Al-Shehari WA, *et al*. Prevalence of hepatitis B virus and hepatitis C virus and associated risk factors among hemodialysis patients in Ibb city-Yemen. PSM Microbiol 2020; 5(2): 32-40.
14. Sallam TA, Raja'a YA, Benbrake MS, *et al*. Prevalence of rubella antibodies among schoolgirls in the city of Sana'a, Yemen. East Mediterr Health J 2003; 9:148–151.
15. Al-Qadasi AR, Rukeimi AA, Shamahy AH, *et al*. Association of Cytomegalo-virus and rubella virus infections in pregnant women with bad obstetric history. World J Gynecol Women's Health 2019; 2(3):1-5. *https://doi.org/10.33552/WJGWH.2019.02.000538*
16. Centers for Disease Control and Prevention (CDC). Health information for international travel, Yellow Book. Prevention of Specific Infectious Diseases 2008; 1-4.
17. Wysokinska T, Janaszek W, Bucholc B, *et al*. The prevalence of anti-rubella antibodies in women of childbearing age in Poland. Vaccine 2004; (22): 1899-1902. *https://doi.org/10.1016/j.vaccine.2003.11.004*
18. Pehlivan E, Karaglu L, Ozen M, *et al*. Rubella seroprevalence in unvaccinated pregnant population in Malatya, Turkey. Public Health 2007; (121): 462-468. *https://doi.org/10.1016/j.puhe.2006.09.021*
19. Olajide MO, Aminu M, Randawa JA, Adejo SD. Seroprevalence of rubella-specific IgM and IgG antibodies among pregnant women seen in a tertiary hospital in Nigeria. Int J Women's Health 2015; 7: 75–83. *http://dx.doi.org/10.2147/IJWH.S68667*
20. Taneja DK, Sharma P. Targeting rubella for elimination. Indian J Public Health 2012; 56(4):269–72. *https://doi.org/10.4103/0019-557X.106413*
21. Peter Lombardo. Dermatological manifestations of rubella work up: Laboratory studies. Med Scape 2015.
22. Gadallah M, El-Sayed N, Kandeel A, *et al*. Seroprevalence of rubella antibodies among adult Egyptian females aged 20-30 years. Is there a need for rubella vaccination? Cent Eur J Public Health 2014; 22: 282-286. *https://doi.org/10.21101/cejph.a4010*
23. Al-Mukhtar HS, Ibrahim HR, Salih SH. Seroprevalence rubella antibodies among young females and women of reproductive age group and pregnant women in Mosul City, Iraq. Pakistan J Med Health Sci 2019; 13(1):271-276.
24. Wondimeneh Y, Tiruneh M, Ferede G, *et al*. Rubella virus infections and immune status among pregnant women before the introduction of rubella vaccine in Amhara regional state, Ethiopia. Int J Infect Dis 2018; 76: 14–22. *https://doi.org/10.1016/j.ijid.2018.07.024*
25. Wang IJ, Huang LM, Chen HH, Hwang KC, Chen CJ. Seroprevalence of rubella infection after national immunization program in Taiwan: Vaccination status and immigration impact. J Med Virol 2007; 79(1):97-103. *https://doi.org/10.1002/jmv.20764*
26. Hamker R, Jalilvand S, Abdolbaghi MH, *et al*. Inadvertent rubella vaccination of pregnant women: Evaluation of possible transplacental infection with rubella vaccine. Vaccine 2006; 24: 3558–3563. *https://doi.org/10.1016/j.vaccine.2006.02.001*