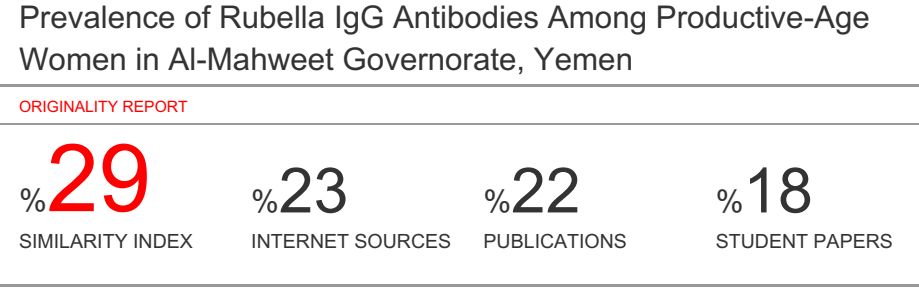
**Reviewer’s Comments**

****

**Prevalence of Rubella IgG Antibodies Among Productive-Age ‎Women in Al-Mahweet Governorate, Yemen**

**Abstract**

**Background:** Rubella is an infectious viral disease caused by the rubella virus. The incidence of (Rubella virus infection in) women during pregnancy ~~stage by rubella infection~~leads to complications for fetus development and~~causing~~(cause) fetal death or congenital rubella syndrome. **Aims:** Thisstudy aimed to determine the prevalence rate of rubella among reproductive-age women in Al-Mahweet, Yemen.**Methods:**~~This~~(A cross sectional) ~~across-sectional~~ study was conducted among femalesattending healthcare (centers) and schoolsfrom July 2007 to June 2008. Blood samples were collected individually from 270 females aged 15-35 years andthe rubella virus IgG antibody was determined 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 rubella IgG antibody 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. There was a significant association between most educational levels and positive results of anti-rubella IgG.~~In regarding~~(With regard to) marital status, the most frequent of rubella antibody was72.3%, 73.1%, and 75.0%, respectively, recorded among single, married, and divorced females. The non-pregnant women had (73.7%) more incidence to rubella antibody than pregnant (66.7%).82.2% of IgG- positive women had no history of stillbirth and 65% had a history of stillbirth. Nearly results were recorded among females had and non-had family history for rubella infection??.**Conclusions**: ~~The~~ most of enrolled females had immunity against rubella virus, but still ~~remark~~(a significant)percentage (were) susceptible to rubella infection. So, (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 disease caused by the Rubella virus. Itis an enveloped, positive, single-stranded RNA virus that belongs to the family Togaviridae1. Humans consider (Humans are considered)the only reservoir for theRubella virus transmitted byairborne 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 weeks2.

In children, the rubella is usually harmlesslycharacterized by only slightly swollen lymph nodes and a mild rash of flat, pink to red spots that persistent for three days. Whereas in adult(it)causes a severe infection that may lead toin?? arthritis or encephalitis3,4.

The most serious effects of the rubella infection occur in pregnant women throughout the first trimester of gestation, resulting in spontaneous abortions, stillbirths and congenital rubella syndrome (CRS). CRS causes heart defects, blindness, deafness, and mental retardation5,6. Globally, approximately 100,000 children are born with CRS each year7.There are no antiviral drugs available for treating rubella or preventing transmission to the fetus. So, it is important that girls obtain immunity to rubella before childbearing age to prevent such serious consequences 8.

Rubella occurs(as) an epidemic in different countries without routine immunization Programs. The prevalence of rubella antibody was 92% recorded among girls aged between 15 and 49 years in Saudi Arabia9 and 94.6% among pregnant women in Iran 10. Also, the prevalence of rubella antibodies was >90.0% in severalAfrican countries among pregnant women and the general population has beenreported11,12. (Also, prevalence of >90% of rubella antibodies among pregnant women and general population has been reported in several African countries11, 12)

In Yemen, many reports documentedthepathogenic virusesprevalent(prevalence) among the population and(but)there are few reports that investigated the prevalence of rubella antibodies13. In Sana’a city, Sallam*et al*. 14 revealed that 91.64% of schoolgirls aged 11-21 were positive for IgGrubella antibodies. Also, the prevalence rate of rubella antibodies was 85.4% among schoolchildren in Sana’a governorate8. Recently,Al-Qadasi*et al*.15 found that 3.7% of pregnant women were positive for rubella IgM antibodies.

Until now, the previous studies on the prevalence of rubella antibodies focused only in Sana’a and there no data (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.

**MATERIALS AND METHODS**

**Study Design and Population**

This across-sectional (cross -sectional)study was conducted in the Maternal and Child center at Al-Jomhory hospital and two secondary schools namely Al- Khansa’a and Aisha, from July 2007 to June 2008, that located in Al-Mahweet governorate.A total of 270 females aged 15-35 years(mean age 21.9 years) (move this part to result section)attending healthcare and schools(were enrolled in the study)Ethical approval??? Participants’ consent???

**Sample SizeCalculation**

The sample size was {calculated by using Epi Info version 6.04 (CDC, Atlanta, USA)(This is wrong!!! Epi Info is not for calculation of sample size but for analysis of collected data) (go get the formula for sample size calculation!! (E.g.TaroYamane 1967; Or Araoye 2004 etc.

with taking into consideration the size of the population in thestudy areathat was 70,000.Also, the expected prevalence of the rubellavirus is 5.0% and the worst acceptable percent is 4.0%, with a confidence level of 99.9%. Therefore, the sample size was 270.

**Data Collection**

A structured and pre-tested questionnaire was approved by the Faculty of Medical Sciences of Sana’a University and subjected???to each participated woman. The questionnaire (wasstructured to) included socio-demographic data (age, residence, marital status, educational level, occupational status), pregnancy status, and history of clinical information. (

**Specimens Collection and Examination**

Five mL of blood samples were collected from each participant by venous puncture and serum separated bycentrifuge. The obtained serastored at –20°C until the serological analysis was performed. The quantitative?? determination of anti-Rubella virus IgG antibody was performed by enzyme-linked immunosorbent assay (ELISA) (Equipar SRL, Italy). The concentration of IgG ant-rubellain serum sample ≥20 IU/mLwere considered positive.

**Statistical Analysis**

The obtained data were analyzed by SPSS version 14 (SPSS Inc., Chicago, IL, USA). The relative risk (RR ˃1), 95% conﬁdence interval (CI), Chi-square test (χ2), and probability value *P*<0.05 (significant) were used to examine the significance of the relationsbetween the prevalence of rubella IgG antibody and potential risk factors.

**RESULTS**

The present results 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).

**Figure 1. The distribution of rubella IgG antibody result**

The current results according to age found that the highest rate of rubella IgG antibody frequency was reported among the 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 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 observed(showed)that the high prevalence 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%. The results of elementary, secondary, primary and finally illiterate in terms of rubella IgG positivity were highly statistically significant with values of χ2 =30.65, *P*=0.000001; χ2 = 29.18, *P*=0.000001; χ2 = 7.04, *P*=0.007 and finally χ2 = 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 participated widow females showed completely positive for the rubella IgG antibody (Table 1).

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Illustrative variables** | | **No. examined (%)** | **No. of positive IgG (%)** | ***RR*** | ***CI*** | **χ2** | ***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; **χ2**Chi-square ≥3.84; *P*<0.01 (significant)

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%) noticed among pregnant women and there were no statistically significant (difference) as summarized in Table (2).

However, out of 130 married females, the rubella IgG antibody was more prevalent among women(who) had no history of stillbirth with (prevalence rate of )82.2% whereas 65% of women(who) hada history of stillbirth showed~~(ing~~) 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*** | χ2 | ***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; **χ2**Chi-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 community16.

The current study revealed that 73% of total females(studied)~~were~~ showed positive for rubella IgGantibodywhile 27% of females were negative. Thesefindings are lower than the rates recorded from several studiesamong women~~that~~where the prevalence rates ofrubella IgG antibody was reported(as)91.64%in Sana’a city14,89.5 % in Poland 17, 85.4%in Sana’a governorate8, 94.4% in Turkey 18, 92% in Saudi Arabia 9, and 94.6% in Iran 10.

However, the lower rate of(than) this study was reported by Olajide *al.*19in Nigeria, revealing~~the~~(that)anti-rubella IgGwas 38.8%~~recorded~~among pregnant and non-pregnant women. Despite the fact that vaccination against rubella is not part of the expanded program of immunization in Yemen, 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 virus20,21.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 ~~is representing~~(represents)a risk for (the) developing ~~the~~ fetus resulting in congenital rubella syndrome5,6.

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~~were~~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 Arabia9, 26-30 years in Egypt22, 26-35 years in Mosul City, Iraq23. The vibration on increase ~~ing~~ 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 theresident group and the prevalence of anti-rubella IgG. Similarly, ~~the~~ higher rate of IgG anti-rubella prevalence t was recorded among females residents in the urban area in Mosul city, Iraq23. Also, it was found that the high rate was recorded among assayed women for rubella IgG antibody living in urban area in Ethiopia24.

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.*22noticed that the participants belong toa rural area having a high rate than participated women coming from an urban area.Olajide *al.*19 found that the prevalence rate of rubella IgG was ~~recorded~~ 93.8% and 90.3% in urban and rural areas, respectively.

The differences in the prevalence rate of anti-rubella IgG in this study might be attributed to variance population density. In the urban area, the high density of the population might increase the transmission rate and femalesdidn’t (who do not) have protective levels of rubella immunity might ~~obtain~~(get) the infections.

In the current result according to theoccupation, it was observed that the high prevalence rate of rubella IgG antibody was recorded among employee(employed)females followed by the student, and house-wife, and there~~also~~were(was) no statistically significantdifferences. Ina 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 student, worker, and housewife (housewives)~~women~~. Also, Wondimeneh*et al*. 24 revealed that most frequency(frequent) ~~of~~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 study, the seroprevalence of rubella in association with the educational level showed that the highest positive results were most frequently reported at the secondary level, followed by the illiterate, university, elementary, and finally the primary level. Also, the statistical analysis results showed the highly significant(p<??)differences betweenanit-rubella prevalence and most of the educational level except individuals having a universitydegree. These results are in agreement with Wang *et al.*25in Taiwan, (that) revealed that there was(statistically) significantly (p>??) associated(association)between the low educational level andsero-negativity 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 *al.*19 registered the illiterate and primary school females showing completely??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~~ing~~ nearly similar ~~in~~anti-rubella prevalence and no statistically significant(p>??) differences.

The variation in previous results to this result may bereferred 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, 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%.Whereas, the two of the participated(participants who were widows~~females~~ showed completely??(comparatively)positive for the rubella IgG antibody. This finding is in agreement with Gadallah*et al*.22 (who) observed that theprevalence rate of anti-rubella IgGwas 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 women23.In fact, all women are susceptible to rubella virus 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. Ina similar study conducted in Poland(it was)found that up to 90% of healthy pregnant females were positive for rubella antibody17.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, found that 82.2% ofIgG-positive study participantswith no a had history of stillbirth were positive, whereas 65% of IgG-positive women had a history of stillbirth. Ina similar study, Olajide*et al*. 19 showed that 92.5% of females with no~~non-had~~history of stillbirth wereIgG-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 threestillbirth.

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~~great~~statistically significant differences between the families with history for rubella and the families without rubella, indicating that previous history for rubella does not (somehow) influence ~~in somehow~~the prevalence of infection.

**CONCLUSION**

The high prevalence of rubellaIgG 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 CRS. Therefore, all females should be vaccinated early for reducing the risk of rubellavirus infection during pregnancy stage and CRS in infants.

**ACKNOWLEDGMENTS**

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

**AUTHOR’S CONTRIBUTION**

The manuscript was carried out, written, and approved in collaboration with all authors.

**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 clinicinLomé, Togo. Am J Infect Dis Microbiol 2015;3(4):134–136. DOI: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.
4. Lezan MM. Prevalence of rubella virus in pregnant women in Kirkuk City-Iraq. KirkutUniv 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.
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 [Available from: <https://www.who.int/immunization/sage/meetings/2012/november/1_Status_Report_Measles_Rubella_22_Oct.pdf>
7. World Health Organization (WHO). Global measles and rubella: Strategic plan 2012-2020 [Internet]. Geneva: WHO; 2012. Available from: <http://www.who.int/immunization/newsroom/Measles_Rubella_StrategicPlan_2012_2020.pdf>
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. doi:10.1016/j.vaccine.2006.05.083
9. Alsibiani AS. Rubella immunity among pregnant women in Jeddah, Western region of Saudi Arabia. Obstetrics and Gynecology International 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, Adadevoh S, Caul EO, Grifﬁn GE. Unseen blindness, unheard deafness, and unrecorded death and disability: Congenital rubella in Kumasi, Ghana. Am J Public Health 2000;90:1555–15561.doi: [10.2105/ajph.90.10.1555](https://dx.doi.org/10.2105%2Fajph.90.10.1555)
12. Cutts FT, Abebe A, Messele T, Dejene A, Enquselassie F, Nigatu W, *et al*. Sero-epidemiology of rubella in the urban population of Addis Ababa, Ethiopia. Epidemiol Infect 2000;124:467–479.DOI: [10.1017/s0950268899003532](https://doi.org/10.1017/s0950268899003532)
13. Almezgagi MM, Edrees WH, Al-Shehari WA, Al-Moyed K, Al-Khwlany RS, Abbas AB. Prevalence of hepatitis B virus and hepatitis C virus and associated risk factors among hemodialysis patients inIbb city-Yemen. PSM Microbiol2020; 5(2): 32-40.
14. Sallam TA, Raja’a YA, Benbrake MS, Al-Shaibani KS, Al-hababi AA. 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, Al-Jaufy YA, Al-Rukeimi AR. Association of Cytomegalo-virus and rubella virus infections in pregnant women with bad obstetric history. World Journal of Gynecology and Women’s Health2019; 2(3):1-5.[DOI: 10.33552/WJGWH.2019.02.000538](http://dx.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, BucholcB,*et al*. The prevalence of anti-rubella antibodies in women of childbearing age in Poland.Vaccine 2004; (22): 1899-1902. DOI: [10.1016/j.vaccine.2003.11.004](https://doi.org/10.1016/j.vaccine.2003.11.004)
18. Pehlivan E, Karaglu L, OzenM,*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. International Journal of 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.DOI: [10.4103/0019-557X.106413](https://doi.org/10.4103/0019-557x.106413)
21. Peter Lombardo. Dermatological manifestations of rubella work up: Laboratory studies. MedScape. 2015 Available from: <http://emedicine.medscape.com/article/1133108-workup> [cited July 28, 2020]
22. Gadallah M, El-Sayed N, Kandeel A, Moussa I, Mohsen A, Dewedar S. 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.DOI: [10.21101/cejph.a4010](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. PJMHS 2019; 13(1):271-276.
24. Wondimeneh Y, Tiruneh M, Ferede G, Abera B, Workineh M, Birhanie M, Tessema B. Rubella virus infections and immune status among pregnant women before the introduction of rubella vaccine in Amhara regional state, Ethiopia. International Journal of Infectious Diseases2018; 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.
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.