**ORIGINAL RESEARCH ARTICLE**

**EVALUATION OF RUBELLA VIRUS SEROLOGICAL MARKERS AMONG ANTENATAL CLIENTS ATTENDING FEDERAL MEDICAL CENTER, KEFFI, NASARAWA STATE, NIGERIA**

**ABSTRACT**

**Background:** Rubella virus infection is a global health challenge that is vaccine preventable. It is one of the leading infections implicated in congenital defects especially in low-income communities with poor health infrastructure. This study assessed the prevalence of rubella virus serological markers among pregnant women in the study area.

**Study Design:** The current study was a cross-sectional.

**Place and Duration of Study:** This study was carried out at the Federal Medical Centre, Keffi Nasarawa State, Nigeria from May to October 2024.

**Method:** A cross-sectional study was conducted involving 300 pregnant women attending antennal care at Federal Medical Center Keffi, Nigeria who consented to participate. Blood samples were collected through vein puncture. The blood samples were processed and analyzed using Rubella Rapid Diagnostic kit (Quindad High Top BioTech Co. Ltd. Hangzhou China). A structured questionnaire was used to inquire about social demographics and associated risk factors.

**Results:** Of the 300 samples analysed, an overall seroprevalence of 2.7% was reported where IgM was 2.0%, and IgG 0.7%. The average age of the participants was 27.5 years, with those aged 26-35 years having the highest number of participants 136(45.3%), while those aged 46-55 years had the least 5(1.7%) with a significant association between the presence of rubella serum markers and age of the participants (*P*=0.05). Participants in their 2nd trimester had the highest prevalence 66.7%, although the age of the pregnancy was not a risk factor for the infection. Other probable risk factors studied were the number of people living in the same household, literacy level, parity, locality, history of blood transfusion and caesarian section, and all of them had no association with rubella virus infection (*P*>0.05).

**Conclusion:** Rubella virus infection is preventable by effective use of vaccine. Vaccination programs including public awareness need to be scaled up in the study area to capture the population at risk and prevent its undesirable outcomes.

**Keywords:** Pregnant Women, Prevalence, Rubella, Serological Markers, Keffi.

**INTRODUCTION**

Rubella, also known as German measles, three-day measles and congenital rubella syndrome (CRS) is a viral infection caused by the rubella virus that primarily affects the skin and lymph nodes (Cao *et al*., 2017; Gubio *et al.,* 2019). Rubella virus is a member of the Togaviridae (Matonaviridae) family, a positive sense single-stranded RNA virus that has an envelope which originates from the host’s plasma cell membrane (ICTV, 2019; Shahapur *et al*., 2020). The virus is contagious and can be transmitted through respiratory droplets, aerosols and direct contact with infected individuals, making it highly transmissible and contagious. It can remain active in the air for up to two hours, increasing the risk of transmission (CDC, 2021; CDC, 2024a). Rubella disease onset usually begins with malaise, low-grade fever, and a morbilliform rash appearing within 24 hours. The rash starts on the face, extends over the trunk and lower limbs, and hardly prolongs beyond 3 days. Unless an epidemic occurs, the disease is difficult to diagnose clinically, as the rash is similar to those caused by other viruses such as enteroviruses (Camejo *et al*., 2025). It is among the vertically transmissible pathogens that can cause congenital infections to the fetus, abortion, intrauterine death, preterm labour or infect the baby prenatally as it passes through the birth canal of the mother during delivery. It is a non-arthropod-borne Togavirus and the only member of the genus Rubivirus (Vueba *et al*., 2022; CDC, 2024b). Rubella virus infection was initially thought to occur only in children, but it was later found to affect all ages and sexes, affect several organs including the eyes, ears, heart, brain and endocrine system (Kolawole & Adekeye, 2017; CDC, 2024b). The virus also can cross the placenta of the infected pregnant mother during the first trimester and cause miscarriage, stillbirth, and congenital rubella syndrome to the baby and can even lead to the mother’s death (WHO, 2024). Rubella virus is sensitive to heat and disinfectants, making its transmission relatively easy to prevent. However, it can still be transmitted through close contact with infected individuals, particularly in crowded or poorly ventilated spaces (CDC, 2021). The World Health Organization recommends that all children receive the MMR (Measles, Mumps and Rubella) vaccine as part of their routine immunization schedule, with additional doses recommended for certain groups, such as healthcare workers and travelers to areas with ongoing rubella outbreaks (CDC, 2021).

**MATERIALS AND METHODS**

**Study Area**: The study area for this research was Keffi and its environs, the city of Keffi, which hosts the Federal Medical Center, is approximately 68km from Abuja the Federal Capital Territory of Nigeria and 128km from Lafia, the capital of Nasarawa State. The 2006 National Census reported that Keffi has an estimated population of 92,664 (NPC, 2006). It is located between Latitude 8o5N of the equator and Longitude 7o8E and situated at an altitude of 850 m above sea level (Akwa *et al*., 2007).

**Study Population:** Pregnant women residing in Keffi and environs attending the antenatal clinic of Federal Medical Center Keffi, Nasarawa State Nigeria were recruited for this study.

**Sample Size Determination:** Theformula described by Sadiq *et al*. (2024) was used for calculating sample size as follows:

N = Z2pq

d2

Where:

N= Minimum sample size

Z= Standard normal distribution at 95% confidence interval 1.96

P= Prevalence of Rubella Virus in previous studies = 17% (0.17) (Kolawole *et al*., 2020).

q= (1 - p) = 0.83

d= precision or margin of error = 5% (0.05)

To substitute the values of the formula N= Z2pq / d2 will mean

N= 1.962 X 0.17 X 0.83

 0.052

N = 216.82

Adding 10% attrition of 216.82 = 21.68, 216.82+21.68 = 238.5

N = 238.5

The total sample was rounded up to 300

**Criteria for Inclusion and Exclusion**: Consenting pregnant females residing within Keffi and environs, accessing antenatal care at the Federal Medical Center Keffi were recruited while females who were not pregnant or pregnant but did not agree to be part of the study were excluded.

**Sample Collection**: Five ml of blood samples were collected aseptically by venipuncture into plain blood sample tubes from each consenting pregnant woman by a trained phlebotomist. The blood samples were coded with date taken and according to numbers assigned to each client. A pretested, validated questionnaire was provided to the clients to obtain clinical, social, reproductive and demographic information.

**Sample Preparation and Storage**: Blood samples obtained from consenting clients were allowed to clot and then centrifuged at 3000rpm for 10 minutes (Cheesebrough, 2006). Each serum was harvested with a sterile calibrated Pasteur pipette, dispensed into a new coded cryovial bottle and stored at −20°C in the Biolab freezer of the Molecular Biology Unit of Federal Medical Center, Keffi until assayed.

**Screening for Rubella Virus IgM and IgG:** Each RV rapid kit pouch contained test cassettes coated with RV antigen particles and antihuman IgG and IgM separately, other materials included were a plastic dropper (pipette), desiccant and buffer. All the blood samples collected were screened for anti-rubella IgM and IgG using lateral flow immunoassay (Quindad High Top BioTech Co. Ltd. Hangzhou China) according to the manufacturer’s instructions. As these specimen particles/mixtures migrate/flow along the length of the test cassette, the anti-RV IgG or IgM antibodies particle complex is captured by the relevant IgG and IgM test bands located in the device window causing a pale to dark red band to form at the test region of the test device window.

**Data Analysis**

The data obtained from this study were analyzed using the Statistical Package for the Social Science (SPSS) version 21 software package at a statistical significance level of p≤0.05 and confidence interval of 95%.

**RESULTS**

**Socio-Demographic Characteristics of Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

The Socio-demographic characteristics of the 300 pregnant women attending antenatal care in Federal Medical Center, Keffi, that were recruited for this study is shown on Table 1. The average age of the participants was 27.5 years, with those aged 26-35 years having the highest number of participants 136(45.3%), while those aged 46-55 years had the least 5(1.7%) Furthermore, 92 (30.7%) resided in the Government Residential Area of Keffi,64(21.3%) Angwan Jaba, 58(19.3%), Angwan Tiv 52(17.3%) while the least sampled participants lived in the Tudun Wada area of Keffi 34(11.3%). When stratified by educational qualification, participants with tertiary education were more 130(43.3%), followed by those with secondary education 70(23.3%), non-formal 53(17.7%) and primary 47(15.7%). Regarding the number of people in their households, those in a household size of 1-5 people were 161 (53.7%) while household size of 6-10 were 139 (46.3%).

**Table 1. Socio-Demographic Characteristics of Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi**

|  |  |
| --- | --- |
| **Parameters** | **No. Screened (%) n=300** |
| **Age (Years)** |  |
| 15-20 | 65 (21.6) |
| 21–25 | 80 (26.7) |
| 26–35 | 136 (45.3) |
| 36–45 | 14 (4.7) |
| 46–55 | 5 (1.7) |
| **Total** | **300** |
| **Residence** |  |
| Angwan Jaba | 64 (21.3) |
| Angwan Tiv | 52 (17.3) |
| GRA | 92 (30.7) |
| Sabon Gari | 58 (19.3) |
| Tudun Wada | 34 (11.3) |
| **Total** | **300** |
| **Education** |  |
| Non-formal | 53 (17.7) |
| Primary | 47 (15.7) |
| Secondary | 70 (23.3) |
| Tertiary | 130 (43.3) |
| **Total** | **300** |
| **No. of people in the house** |  |
| 1-5 | 161 (53.7) |
| 6-10 | 139 (46.3) |
| **Total** | **300** |

**Probable Predisposing Factors to Rubella Virus.**

Pregnant women who had history of rubella infection were 99(33.0%), while those who were not sure were 95(32.0%) against the class of women who had never had rubella virus infection 106(35.0%). Among these pregnant women, those who had taken rubella containing vaccine or measles mumps rubella vaccine were 60(20.0%) against 115(38.3%) that had not taken while 125(41.7%) were not sure if they had taken the vaccine. The participants who had a history of blood transfusion were 146 (48.7%) compared to 154(51.3%). Those with a history of caesarian section were 153 (51.0%) while 147 (49.0%) had never had a caesarian section before. The stage of their pregnancies as at the time of the study showed that most of them were in their 2nd trimester 120(40.0%), followed by those in their 1st trimester 100(33.3%) and 3rd trimester with the least participants 80(26.7%). Regarding the number of times the participants have given birth as at the time of this study, nulliparous women had the least participants 120(40%) while the multiparous had the highest 180(60%) (Table 2).

**Table 2. Some Probable Predisposing Factors to Rubella Virus Infection Among Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi**

|  |  |
| --- | --- |
| **Parameters** | **No. Examined (%) n=300** |
| **History RUBV** |  |
| Yes | 99 (33) |
| No | 106 (35) |
| Don’t Know | 95 (32) |
| **Total** | **300** |
| **Rubella Containing Vaccine/Others** |  |
| Yes | 60 (20.0) |
| No | 115 (38.3) |
| Not Sure | 125 (41.7) |
| **Total** | **300** |
| **Transfusion History** |  |
| Yes | 146 (48.7) |
|  No | 154 (51.3) |
| **Total** | **300** |
| **Caesarian Section**  |  |
| Yes | 153 (51.0) |
| No | 147 (49.0) |
| **Total** | **300** |
| **Trimester** |  |
| First  | 100 (33.3) |
| Second  | 120 (40.0) |
| Third  | 80 (26.7) |
| **Total** | **300** |
| **Parity** |  |
| Nulliparous | 120 (40.0) |
| Multiparous | 180 (60.0) |
| **Total** | **300**  |

**Clinical Symptoms among Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

With respect to common clinical symptoms of rubella infection, 172 (57.3%) participants had rashes while 128 (42.7%) did not have. Similarly, the incidence of Papule was reported in 73 (24.3%) of them, fever was experienced by 159 (53.0%) and Malaise in 181 (60.3%) (Figure 1).

**Figure 1. Clinical Symptoms among Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

**Prevalence of RUBV Antibodies**

Of the 300 participants screened using the rubella rapid diagnostic assay, there was a prevalence of 2.0% and 0.7% of detectable IgM and IgG respectively with an overall seropositivity of 2.7%. The average age of the participants was 27.5 years, with those aged 26-35 years having the highest number of participants 136(45.3%), while those aged 46-55 years had the least 5(1.7%) with a significant association between the presence of rubella serum markers and age of the participants (*P*=0.05). With respect to Parity, the nulliparous participants had IgM prevalence of 1.7% and IgG prevalence of 2.2%, while the Multiparous participants had an IgM prevalence of 2.2% and an IgG prevalence of 0.6%, though there was no statistical significance (P>0.05) (Table 3).

**Table 3. Prevalence of RUBV IgM/IgG with Respect to Age and Parity of Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameters** | **No. Examined (%)** | **RUBV IgM (%)** | **RUBV IgG (%)** | **Total (IgM+IgG%)** |
| **Age (Years)** |  |  |  |  |
| 15-20 | 65 (21.7) | 1 (1.5) | 1 (1.5) | 2 (3.1) |
| 21–25 | 80 (26.7) | 2 (2.5) | 0 (0.0) | 2 (2.5) |
| 26–35 | 136 (45.3) | 2 (1.5) | 1 (0.7) | 3 (2.2) |
| 36–45 | 14 (4.7) | 1 (7.1) | 0 (0.0) | 1 (7.1) |
| 46–55 | 5 (1.7) | 0 (0%) | 0 (0.0) | 0 (0.0) |
| **Total** | **300** | **6 (2.0)** | **2 (0.7)** | **8 (2.7)** |
| **X2** | **23.2867** |  |  |  |
| **p-value** | **0.0030** |  |  |  |
| **Parity** |  |  |  |  |
| Nulliparous | 120 (40.0) | 2 (1.7) | 1 (0.8) |  3(2.5) |
| Multiparous | 180 (60.0) | 4 (2.2) | 1 (0.6) |  5(2.8) |
| **Total** | **300** | **6 (2.0)** | **2 (0.7)** | **8(2.7)** |
| **X2** | **0.9140** |  |  |  |
| **p-value** | **0.9081** |  |  |  |

Regarding the place of residence, a higher prevalence of 5.8% was observed among those residing in Angwan Tiv area compared to 3.1%, for Angwan Jaba. Tudun Wada had 2.9%, Sabon Gari 1.7% while the least was recorded among those residing in GRA area 1.1% (P>0.05). Furthermore, the prevalence regarding level of education was found to be higher among those who had a non-formal education 5.7%, followed by those with secondary education 2.9%, primary education 2.1 and the least was for those with tertiary education 1.5% (>0.05). Regarding the household size, those who had 6-10 members had a higher prevalence of 2.8%, while those with 1-5 members had a prevalence 2.5% (P>0.05) (Table 4).

**Table 4. Prevalence of Rubella Virus Infection with respect to Place of Residence, Education and Household Size of Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | No. Examined (%) | RUBV IgM (%) | RUBV IgG (%) | Total (IgM+IgG %) |
| Residence |  |  |  |  |
| Angwan Jaba | 64 (21.3) | 2 (3.1) | 0 (0.0) | 2 (3.1) |
| Angwan Tiv | 52 (17.3) | 2 (3.8) | 1 (1.9) | 3 (5.8) |
| GRA | 92 (30.7) | 0 (0.0) | 1 (1.1) | 1 (1.1) |
| Sabon Gari | 58 (19.3) | 1 (1.7) | 0 (0.0) | 1 (1.7) |
| Tudun Wada | 34 (11.3) | 1 (2.9) | 0 (0.0) | 1 (2.9) |
| Total | **300** | **6 (2.0)** | **2 (0.7)** | **8 (2.7)** |
| X2 | **1.9379** |  |  |  |
| p-value | **0.9820** |  |  |  |
| Education |  |  |  |  |
| Non-formal | 53 (17.7) | 2 (3.8) | 1 (1.9) | 3 (5.7) |
| Primary | 47 (15.7) | 1 (2.1) | 0(0.0) | 1 (2.1) |
| Secondary | 70 (23.3) | 2 (2.9) | 0 (0.0) | 2 (2.9) |
| Tertiary | 130 (43.3) | 1 (0.8) | 1 (0.8) | 2 (1.5) |
| Total | **300** | **6** (2.0) | **2 (0.7)** | **8 (2.7)** |
| X2 | **2.7064** |  |  |  |
| p-value | **0.8441** |  |  |  |
| Household Size |  |  |  |  |
| 1-5 | 161 (53.7) | 2 (1.2) | 1 (0.6) | 3 (2.5) |
| 6-10 | 139 (46.3) | 4 (2.9) | 1 (0.7) | 5 (2.8) |
| Total | **300** | **6 (2.0)** | **2 (0.7)** | **8 (2.7)** |
| X2 | **0.9855** |  |  |  |
| p-value | **0.6200** |  |  |  |

The prevalence regarding some risk factors was assessed revealing a prevalence of 2.4% among participants that had between 9-11 children, while it was 2.2 for those that had 0-2 children (P>0.05). Also, those in the first trimester had a higher prevalence of 4.0% followed by those in the second trimester than those in the third trimester 1.3% (P>0.05). Moreover, those that had caesarian section had a higher prevalence 3.3% than those who have not had a caesarian section before 2.0% (P>0.05). Additionally, those that had a history of blood transfusion had a higher prevalence of 4.1% than those who haven’t been transfused with blood before 1.3% (P>0.05) (Table 5).

**Table 5. Prevalence of Rubella Virus Infection with Respect to Probable Risk Factors Among Pregnant Women Attending Antenatal Care at Federal Medical Center, Keffi.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | No. Examined (%) | RUBV IgM (%) | RUBV IgG (%) | Total (IgM+IgG %) |
| No. of Children |  |  |  |  |
| 0-2 | 135 (45) | 2 (2.2) | 1 (0.7) | 3 (2.2) |
| 3-5 | 73 (24) | 2 (2.7) | 0 (0.0) | 2 (2.7) |
| 6-8 | 51 (17) | 1 (1.9) | 1(1.9) | 2 (3.9) |
| 9-11 | 41 (14) | 1 (2.4) | 0 (0.0) | 1 (2.4) |
| Total | **300** | **6 (2.0)** | **2** (0.7) | **8 (2.7)** |
| X2 | **1.2837** |  |  |  |
| p-value | **0.9725** |  |  |  |
| Trimester |  |  |  |  |
| First | 100 (33.3) | 3 (3.0) | 1 (1.0) | 4 (4.0) |
| Second | 120 (40.0) | 2 (1.7) | 1 (0.8) | 3 (2.5) |
| Third | 80 (26.7) | 1 (1.3) | 0 (0.0) | 1 (1.3) |
| Total | **300** | **6**(2.0) | **2 (0.7)** | **8 (2.7)** |
| X2 | **0.8486** |  |  |  |
| p-value | **0.931** |  |  |  |
| Rubella Containing Vaccine |  |  |  |  |
| Yes | 60 (20.0) | 1 (1.7)  | 0 (0.0) | 1 (1.7) |
| No | 115 (38.3) | 1 (0.9)  | 1 (0.9) | 2 (1.7) |
| Not Sure | 125 (41.7) | 4 (3.2)  | 1 (0.8) | 5 (3.6) |
| Total | **300** | **6 (2.0)**  | **2** (0.7) | **8 (2.7)** |
| X2 | **1.973** |  |  |  |
| Caesarian Section  |  |  |  |  |
| Yes | 153 (51.0) | 4 (2.6)  | 1 (0.7) | 5 (3.3) |
| No | 147 (49.0) | 2 (1.4)  | 1 (0.7) | 3 (2.0) |
| Total | **300** | **6 (2.0)**  | **2 (0.7)** | **8 (2.7)** |
| X2 | **0.5793** |  |  |  |
| p-value | **0.748** |  |  |  |
| Transfusion History |  |  |  |  |
| Yes | 146 (48.7) | 5 (3.4)  | 1 (0.7) | 6 (4.1) |
| No | 154 (51.3) | 1 (0.6)  | 1 (0.6) | 2 (1.3) |
| Total | **300** | **6 (2.0)**  | **2** (0.7) | **8 (2.7)** |
| X2 | **2.8285** |  |  |  |
| p-value | **0.243** |  |  |  |

**DISCUSSION**

Rubella virus is the only known pathogen implicated as the causative agent of congenital rubella syndrome (CRS). It needs a dynamic approach to study, to bring to a bare minimum the burden of rubella disease and its complications in congenital abnormalities (Anthony & Ashley, 2019). In this study, IgM and IgG were used as surrogates of infection. IgM is the first immunoglobulin produced as a primary response to rubella infection indicating the acute and recent nature of the infection while IgG is highly specific and its detection signifies intermediate, chronic and or past history of an infection, which may not be actively infectious. In this study, of the 300 pregnant women screened, an overall prevalence of 2.7% was recorded, from IgM and IgG seropositivity of 2.0% and 0.7% respectively. This finding is comparable to that reported in some parts of Nigeria. For instance, Bola *et al.* (2021) reported 3.1% prevalence in Ekiti State, while Abdulkadir *et al.* (2021) reported 4.0% in Kano State. However, it is in contrast to a prevalence of 11.4% by Pennap & Egwa (2016) Nasarawa State; 18.72% by Ekuma *et al.* (2022) in Ebonyi State and 68.7% by Zahradeen *et al.* (2023) in Kano State, as well as 89.0% by Kassa *et al.* (2020) reported in a meta-analysis study in Sub-Saharan Africa. Differences in sample size, location, method of analysis and sensitivity of the test used may be responsible for the disparity (Colman *et al.,* 2021; CDC, 2024c; Waziri *et al.,* 2024). With respect to the type of Immunologlobulin detected, there were more women with current infection than past infection (2.0% versus 0.7% respectively). The danger to the unborn fetus while in this condition has been reported by several researchers (Zahradeen *et al.,* 2023).

The age distribution of rubella infection indicated that the current infection occurred most among those aged 36-46 years. The association between infection and age was statistically significant (*P*=0.05). This is similar to reports from study by Zahradeen *et al.* (2023) in Kano. In contrast, studies in Jos of Plateau State reflect a trend where age was not a risk factor for the virus infection (Waziri *et al*., 2024).

In this study, pregnant women who were nulliparous and multiparous had a seroprevalence of 2.5% and 2.8% respectively. This result is lower compared to the results of the study by Rabiu *et al.* (2020) in Kano, who reported a prevalence of 34.00% and 55.00% among nulliparous and multiparous women respectively. Ekuma *et al.* (2022) reported a prevalence of 22.7% among multiparous pregnant women. This suggests that a woman’s childbirth history does not influence her risk of infection by this virus.

The residential area is generally passive as a social factor which may aid in the spread of infection. Data from this study suggest that the observed difference in Rubella seroprevalence across different areas of residence were not statistically significant (*P*>0.05). This suggest that the virus infection is regardless of the area of residence. This corroborates the study in Kano by Rabiu *et al.* (2020) as well as that by Abdullahi & Sime (2018) in Adamawa State. This means that the virus transmission occurs irrespective of whether it is an urban or rural areas. The absence of any significant difference might suggest that factors such as healthcare access, vaccination programs, or living conditions do not create meaningful disparities in Rubella exposure between areas. This is in contrast to the study by Ekuma *et al.* (2022) in Ebonyi State which reported a correlation between area of residence and rubella transmission. Similar studies by Adewunmi *et al.* (2015), Kolawole *et al.* (2020) and Zahradeen *et al*. (2023) conducted in different parts of Nigeria were silent about the area of residence as a significant risk factor.

There was no significant association between Rubella infection and educational attainment of the pregnant women. Most of the participants had up to school leaving certificate, similar to the studies reported by Gubio *et al.* (2019) in Zaria and Waziri *et al*. (2024) in Jos. At a 95% confidence level, the findings confirmed that educational level did not significantly influence Rubella virus infection in the study population (*P*>0.05). However, Ekuma *et al*. (2022) and Akele *et al.* (2019) in their study carried out in Ebonyi reported a significant increase in infection among the uneducated class. This difference might be due to the difference in sample size, geographical location as well as the method of sample collection and analysis. For example, an increase in sample size may increase the chances of detection, particularly if the population is heavily skewed toward certain categories of education.

Similarly, the number of people living together in the same household had no direct correlation with the prevalence of the virus, even though it was slightly arithmetically higher among those with household size of six and above. Although, the virus is primarily transmitted through respiratory droplets in close contact, the household size could theoretically increase exposure risk, as suggested by Jallow *et al.* (2022) in Senegal. However, herd immunity may have mitigated the impact of household crowding on Rubella transmission in the study population. Also, transmission may not be directly influenced by the number of people living in the household but by other factors, such as cross ventilation, personal hygiene practices, vaccination coverage, and community-level transmission, might be more critical determinants of infection risk (Anthony & Ashley, 2019).

With respect to clinical symptoms of rubella infection, the findings of this study confirmed that the presence of a rash, malaise, or fever did not significantly influence the likelihood of Rubella IgM and IgG seropositivity among pregnant women (*P*>0.05) as was also reported by Kolawole *et al.* (2015) in Lokoja. The lack of a significant relationship suggests that having a rash, malaise or fever are not a reliable indicator of recent Rubella infection, as reflected by the IgM positivity. This could be because a rash alone is not specific to Rubella and can be caused by many other viral or bacterial infections (Balarabe *et al.,* 2020). While a rash, fever or malaise are common symptoms of the virus infection, not all may present during an infection. Some women may have the infections without the classic rash, especially if they have mild or atypical cases of the disease. There was, however, a significant association between the appearance of papule and rubella infection in this study (*P*=0.05), as was that reported by Zahradeen *et al.* (2023). The presence of papules may reflect a stage in Rubella infection when the immune system is actively responding to the virus, leading to IgM positivity. The result supports the fact that Rubella can manifest with papules, and this finding could be used as a clinical sign to consider for further diagnostic testing for the virus.

Women with more children (9-11 children) did not appear to have a higher or lower likelihood of the recent infection, suggesting that exposure to the virus or immunity to it is not directly related to the number of children. Rubella infection could occur in individuals at any stage of reproductive history, irrespective of having children with rubella, or the number of children.

Women in their second trimester were the most participants and there was no significant association between Rubella infection and the age of pregnancy in this study. This suggests that the infection is not influenced by the stage of pregnancy. The same observation was reported by Zahradeen *et al.* (2023) and Rabiu *et al.* (2020). Conversely, Adewunmi *et al.* (2015), Akele *et al.* (2020), and Kolawole *et al.* (2020) reported the first trimester as the most vulnerable with its attendant complications. Rubella exposure risk may be independent of the stage of pregnancy and influenced more by environmental or community-level factors, such as socio-economic status, and access to healthcare (Bianchi *et al*., 2022; Mohammed, 2024).

Receiving a Rubella-containing vaccine/Measles, Mumps, Rubella vaccine was not significantly associated (*P*>0.05) with the likelihood of testing positive for Rubella infection in pregnant women, as was comparatively reported among children in Jos, Nigeria by Waziri *et al.* (2024). This implies that the vaccine status of the women in this study did not appear to significantly affect their immunity to Rubella in a way that led to detectable levels of IgG and IgM antibodies. This is in agreement with a similar study in Senegal by Jallow *et al.* (2022). A key possibility is that vaccine-induced immunity may be present in most women who received the Rubella-containing vaccine, and therefore, they may not have had recent Rubella infections that would lead to IgM positivity. The study did not account for how long ago the women were vaccinated. Immunity to Rubella from vaccination can last for many years, and older vaccine recipients might not have been exposed to Rubella recently, hence no IgM response. It is also possible that the women who were vaccinated had been vaccinated at different times or with different types of vaccines, which could influence the effectiveness and duration of immunity, potentially leading to variation in IgM positivity (Haralambieva *et al*., 2020). Some sub-Saharan African research link pregnancy complications to heightened incidents of infectious diseases due to lower vaccination coverage, poor access to prenatal care and increased instances of infectious diseases during pregnancy, correlating with poor healthcare infrastructure (Osinubi *et al*., 2020; Togbe *et al*., 2021).

The study also looked at the history of Caesarian section and blood transfusion among pregnant women as possible risk factors of infection but there was no significant association with rubella infection (*P*>0.05). This is in agreement with Rabiu *et al*. (2020) and Alaoui *et al.* (2023).

There were some limitations in this study which need to be taken into consideration. As a result of limited resources, the rapid diagnostic rubella test kit was used for the detection of rubella antibodies. Another important limitation was the inability of the participants to provide evidence of rubella vaccination. Furthermore, the study focused on a population in a semi urban area, as a result, the outcome cannot be extended to pregnant women in rural areas. More studies need to be carried out involving more health centers especially in rural areas with limited access to healthcare.

**CONCLUSION**

This study reported an overall seroprevalence of 2.7% rubella infection in the study population. Using IgM and IgG as surrogates of rubella infection, prevalence was 2.0% and 0.7% respectively, as an indication of current (IgM) and past (IgG) rubella virus infection among pregnant women in the study population. The sociodemographic factors studied, such as residence, education and household size had no significant association with rubella virus. There was also no association of rubella virus infection with probable risk factors such as parity, trimester, common clinical features like fever, rash, malaise and uptake of rubella containing vaccine but the presence of papule had significant association with the virus infection. Similarly, the age of the pregnant women was found to be significantly associated with the infection with those within the age groups 36-45 years having a high-risk factor for the infection. The findings of this study offer a means of encouraging the diagnosis of congenital rubella infection in developing countries such as Nigeria where routine diagnosis of rubella is not carried out.

**Consent**

Written consent was obtained from all subjects after explaining the entire research protocol and justification to them in their acceptable language.

**Ethical Approval**

Institutional ethical approval was obtained from the Health Research Ethics Committee of the Federal Medical Centre Keffi, Nasarawa State (FMC/KF/HREC/02631/24).

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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